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The Burning Building

Winnie Tu

THE BURNING BUILDING
FIRE AS PLACE

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Thesis Preparation
Fall 2015

The Burning Building
Fire as Place

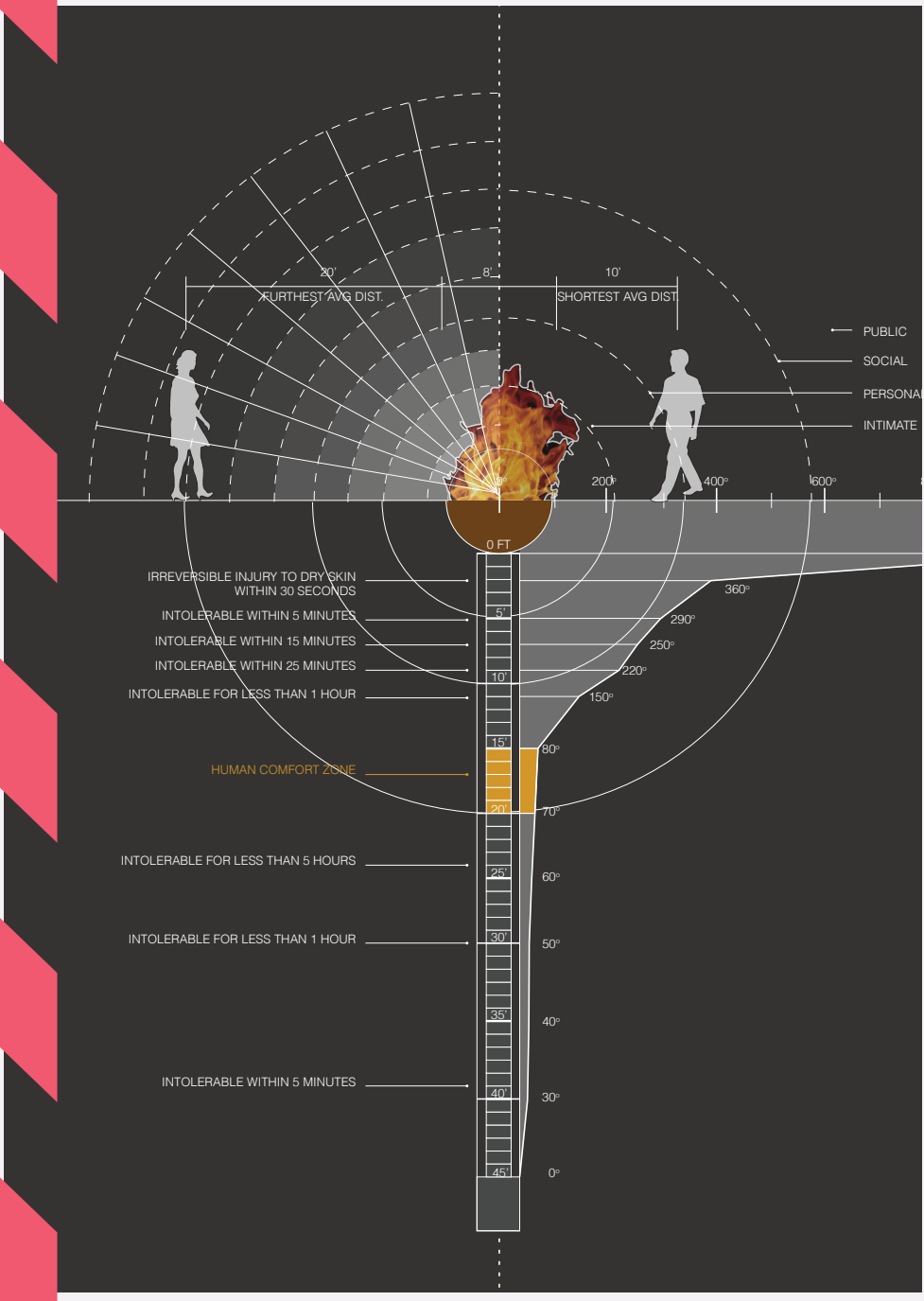
The importance of fire in human social evolution is widely acknowledged but the extent of its impact is not fully explored. Generally, it is connected to energy, light, purification, illumination, creation, destruction and metamorphosis. Fire's paradoxical nature has built up many societies throughout human history and has been the primary social driver within communities. Due to technological advances, its energy has been transformed into a distant element which is being used discretely in industrial buildings, hidden under basements, or replaced by other forms of energy. Now, heat, energy, and light is readily available anywhere at any time, eliminating the biological need for a centralized source of life. As a result, fire has lost its original symbol in society as the life giving entity of the home and of the city. Strict fire regulations have further relinquished the use of fire in contemporary society. This ultimately plays a role in society's shift towards individualistic rather than collective organization - extinguishing the original formulation of community.

When fire is controlled, research confirms that hearth and campfires induce relaxation as part of a multi sensory, absorptive, and social experience. Because fire ties heavily with community formation, this thesis aims to directly reintroduce the element of fire as a social phenomenon measured through four scales of human proxemics: public, social, personal, and intimate. Since fire involves flickering light, crackling sounds, warmth, and has a distinctive smell, the architecture will be designed around the exploration of these characteristics and its spatial qualities through the control of construction as well as heat and light dissipation to result in the design of a cyclically transformative burning building.[1]

[1][The idea of a "burning building" is being redefined not as a building being decayed, but rather a study of how reintroducing fire back into Architecture can create a centralized social phenomenon within the public realm through the design of a transformative process.]

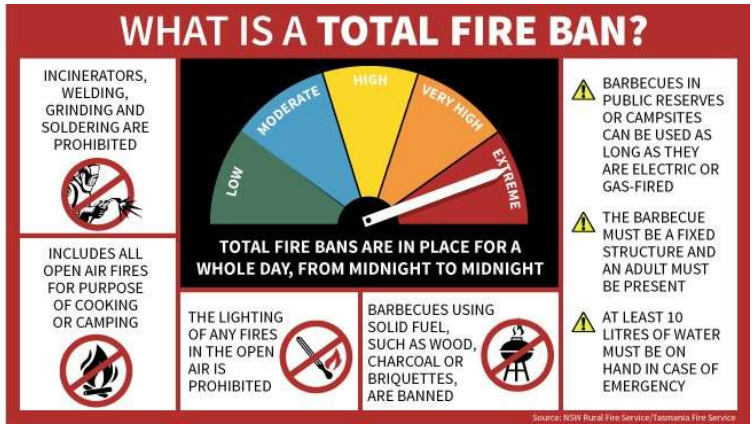
Advisor: DAEKWON PARK

WINNIE TU


20'
FURTHEST AVG DIST.
8'
10'
SHORTEST AVG DIST
PUBLIC
SOCIAL
PERSONAL
INTIMATE
200°
400°
600°
0 FT
IRREVERSIBLE INJURY TO DRY SKIN WITHIN 30 SECONDS
INTOLERABLE WITHIN 5 MINUTES
INTOLERABLE WITHIN 15 MINUTES
INTOLERABLE WITHIN 25 MINUTES
INTOLERABLE FOR LESS THAN 1 HOUR
HUMAN COMFORT ZONE
INTOLERABLE FOR LESS THAN 5 HOURS
INTOLERABLE FOR LESS THAN 1 HOUR
INTOLERABLE WITHIN 5 MINUTES
5'
10'
15'
20'
25'
30'
35'
40'
45'
360°
290°
250°
220°
150°
80°
70°
60°
50°
40°
30°
0°


~~WE MADE A FIRE!~~
~~GATHER AROUND THE FIRE!~~
~~RUN! THERE'S A FIRE!~~
~~DON'T START A FIRE!~~
WHERE'S THE FIRE?

THE FIRE IS GONE FROM ARCHITECTURE



SUMMARY

The importance of fire in human social evolution is widely acknowledged but the extent of its impact is not fully explored. Generally, it is connected to energy, light, purification, illumination, creation, destruction and metamorphosis. Fire's paradoxical nature has built up many societies throughout human history and has been the primary social driver within communities. Due to technological advances, its energy has been transformed into a distant element which is being used discretely in industrial buildings, hidden under basements, or replaced by other forms of energy. Now, heat, energy, and light is readily available anywhere at any time, eliminating the biological need for a centralized source of life. As a result, fire has lost its original symbol in society as the life giving entity of the home and of the city. Strict fire regulations have further relinquished the use of fire in contemporary society. This ultimately plays a role in society's shift towards individualistic rather than collective organization - extinguishing the original formulation of community.

WHAT DRAWS US TOWARDS FIRE?

When fire is controlled, research confirms that hearth and campfires induce relaxation as part of a multi sensory, absorptive, and social experience. Because fire ties heavily with community formation, this thesis aims to directly re-introduce the element of fire as a social phenomenon measured through four scales of human proxemics: public, social, personal, and intimate. Since fire involves flickering light, crackling sounds, warmth, and has a distinctive smell, the architecture will be designed around the exploration of these characteristics and its spatial qualities through the control of construction as well as heat and light dissipation to result in the design of a cyclically transformative burning building.[1]

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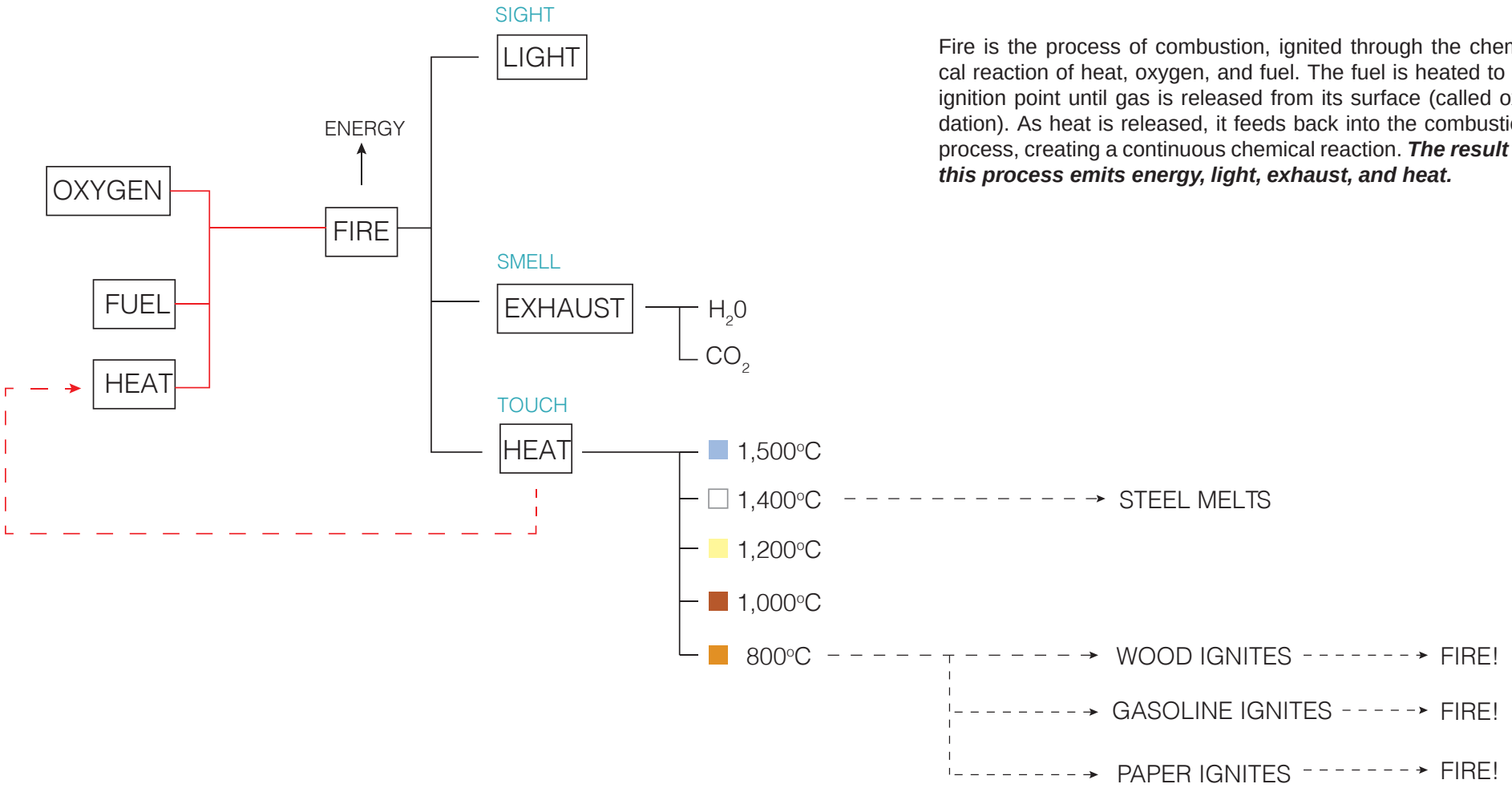
CONTENTS

01 WHAT IS FIRE?

FIRE IS COMBUSTION

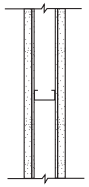
PROCESS OF FIRE



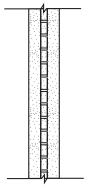
Fire is the process of combustion, ignited through the chemical reaction of heat, oxygen, and fuel. The fuel is heated to its ignition point until gas is released from its surface (called oxidation). As heat is released, it feeds back into the combustion process, creating a continuous chemical reaction. ***The result of this process emits energy, light, exhaust, and heat.***

FIRE RATED WALLS AND PARTITIONS

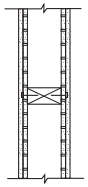
1 HOUR RATED



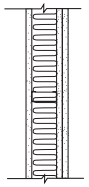
METAL STUDS,
GYPSUM PLASTER



STUDLESS SOLID
GYPSUM PLASTER

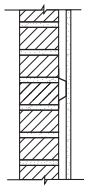


WOOD STUDS AND
GYPSUM PLASTER

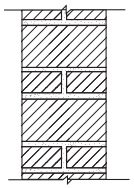


METAL STUDS, GYPSUM
WALLBOARD, MINERAL FIBER

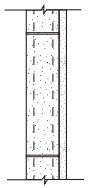
2 HOUR RATED



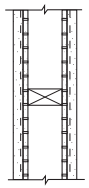
BRICK WITH 1/2" TYPE X
GYPSUM WALLBOARD



8" CLAY BRICK

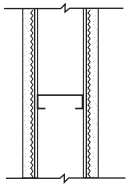


HALLOW GYPSUM
TILE AND PLASTER

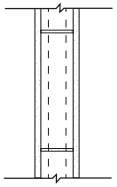


WOOD STUDS AND
GYPSUM PLASTER

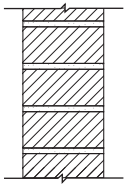
3 HOUR RATED



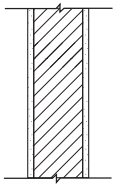
METAL STUDS AND
GYPSUM PLASTER



HALLOW GYPSUM TILE
AND PLASTER

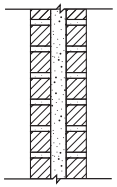


8" BRICK

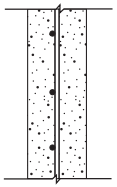


4" HALLOW BRICK

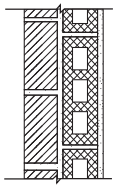
4 HOUR RATED



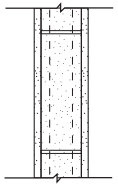
8" HALLOW BRICK,
LOOSE-FILL INSULATION



SOLID CONCRETE WALL
GRADES A AND B



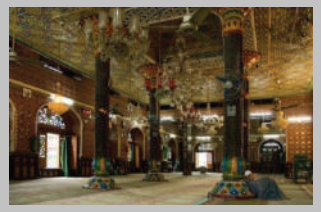
CLAY BRICK AND
HALLOW CLAY TILE



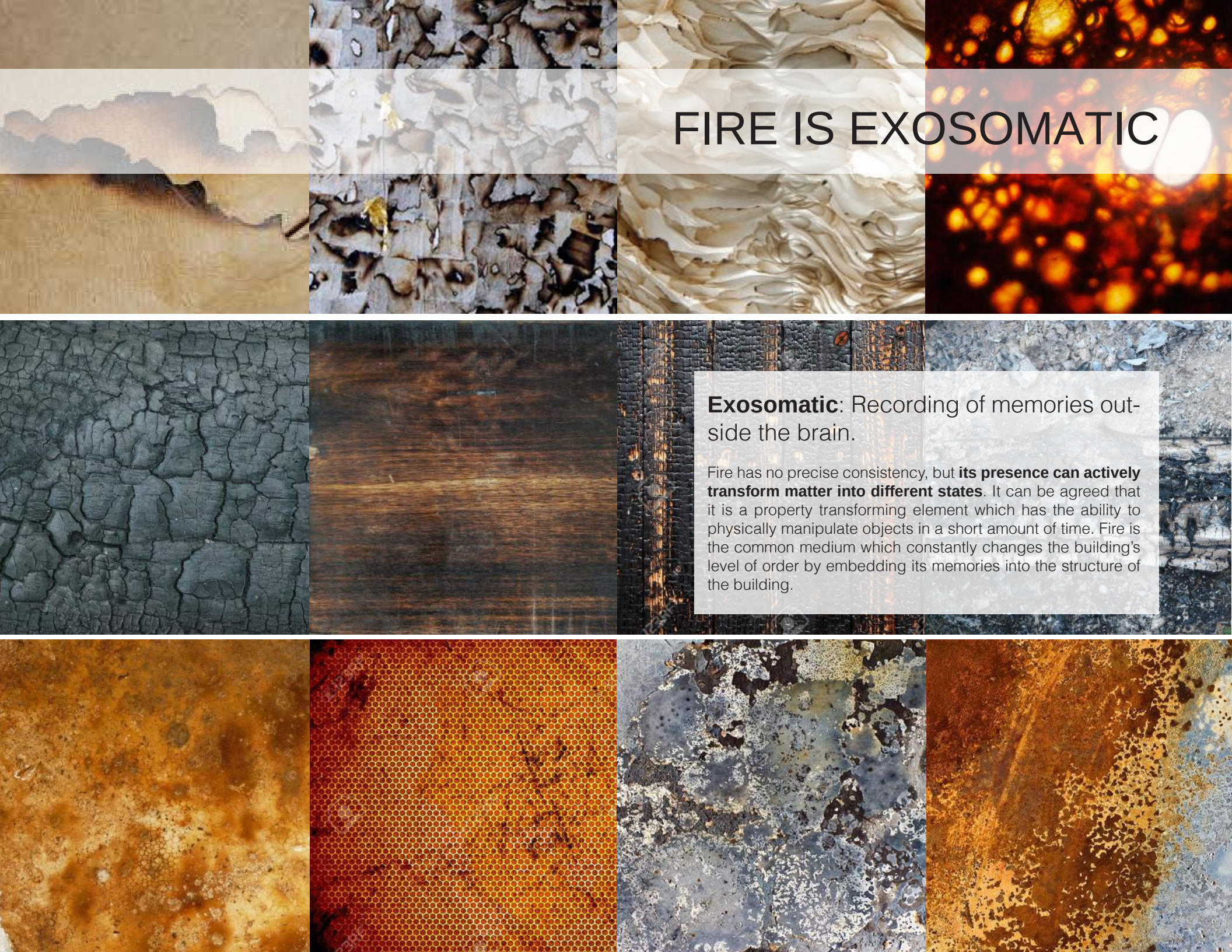
HALLOW GYPSUM TILE
AND PLASTER

FIRE IS CONSTRUCTION

All buildings are designed around fire. The idea of fire infiltrates every aspect of contemporary architectural construction guided by building codes and fire regulations. The relation of this element in Architecture remains a passive one as buildings are constructed to resist and decelerate the effects of combustion. Fire is ultimately one of the largest influence of the built environment, whether it is present or not.



Peer Gastgir Sahib Shrine Fire, Resisting fire through the process of "slow burning" heavy timber construction Photo by Jason Pemberton, Photopedia.com



FIRE IS EXOSOMATIC

Exosomatic: Recording of memories outside the brain.

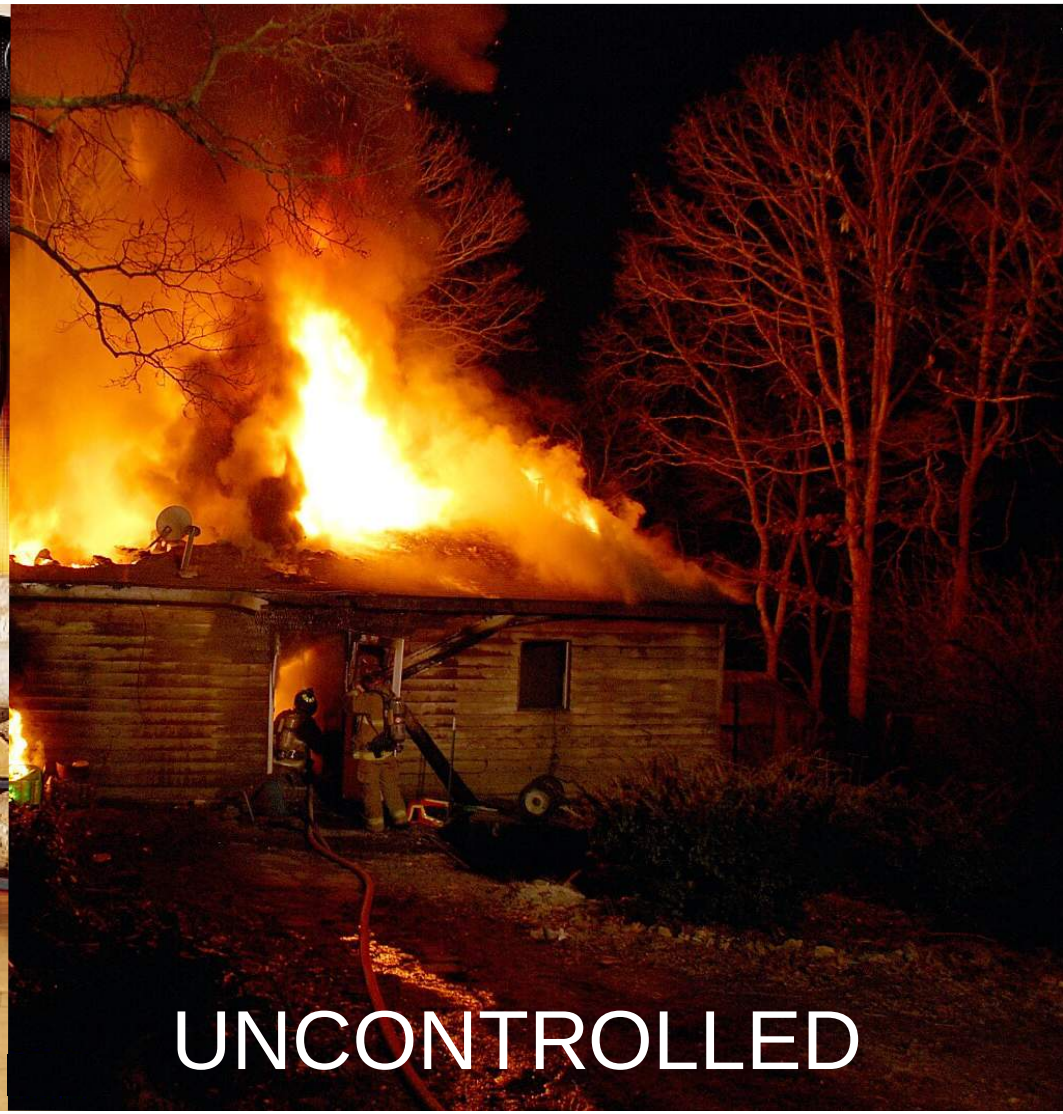
Fire has no precise consistency, but **its presence can actively transform matter into different states**. It can be agreed that it is a property transforming element which has the ability to physically manipulate objects in a short amount of time. Fire is the common medium which constantly changes the building's level of order by embedding its memories into the structure of the building.

FIRE IS PARADOXICAL

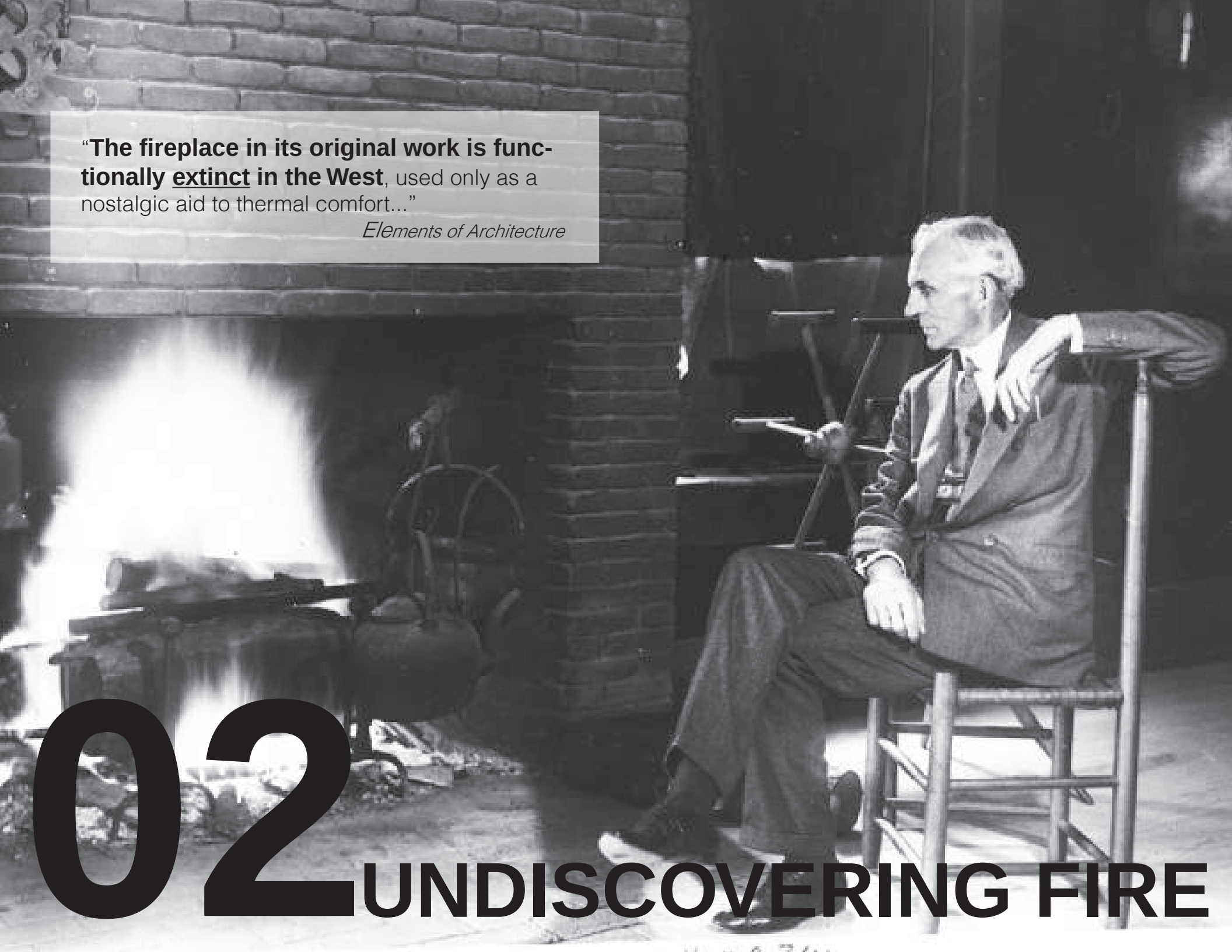
Fire stands as the origin of radiant ***warmth and light***. Ultimately, the fireplace is the center of the house. It is the life giving element which transforms the building shell into a living entity.

If not properly tended, its benign character can quickly become a ***dangerous and apocalyptic*** nightmare. It has the ability to swallow cities and forests - joining together things that were once separate and burning them until they become unrecognizable rubble.

CONTROLLED



UNCONTROLLED



"**The fireplace in its original work is functionally <u>extinct</u> in the West**, used only as a nostalgic aid to thermal comfort..."

Elements of Architecture

02 UNDISCOVERING FIRE

“Fire has been crucial to human survival for around one million years, and in that time, humans have evolved psychological mechanisms specifically dedicated to controlling it. But because most Westerners no longer learn how to start, maintain and use fire during childhood, we instead wind up with a curious attraction to it — a burning desire left to languish.”

-Wolchover

HOW WE EXPERIENCE FIRE IN CONTEMPORARY SOCIETY

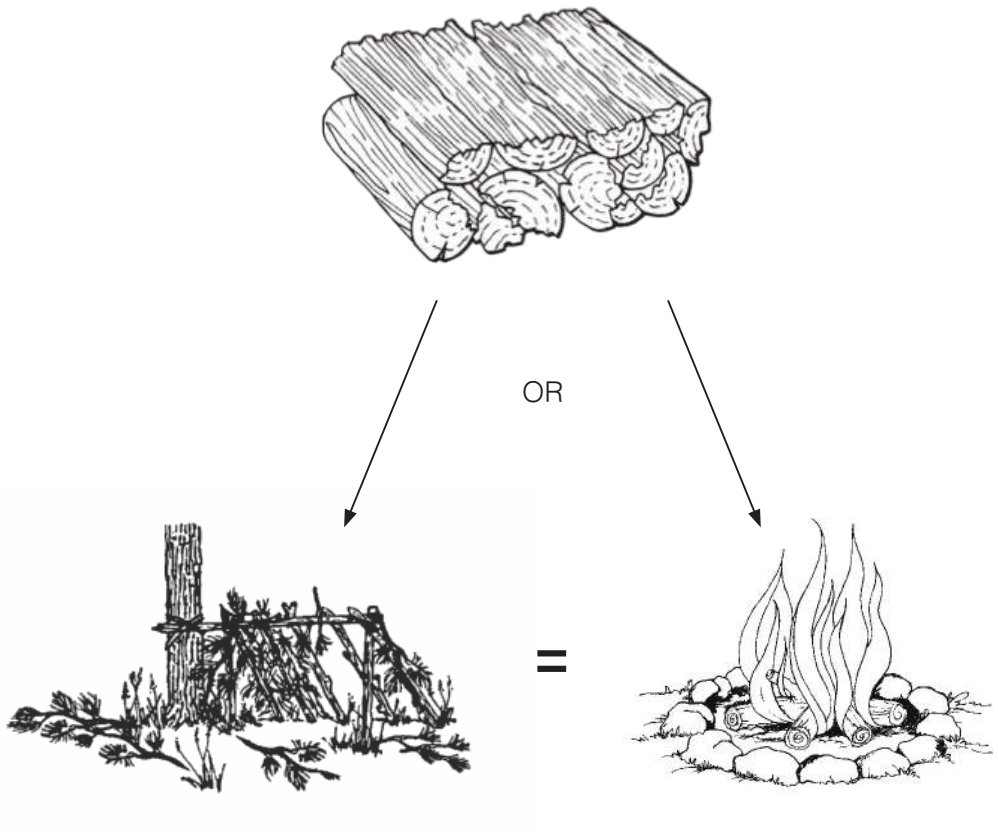
The discovery of fire in Cesariano's Vitruvius (1521).

BACKGROUND

"*Fire is a synonym for the flow of life, which architecture serves.*"
-Josep Lluis Mateo

In ancient times, fire was seen as the primeval element, one of the many myths competing for the origin of how Architecture was formed. Fire is associated with energy, with the thermal adaptation needed for human life, and for handling and producing the materials, such as metal, glass, food, that are fundamental in survival.

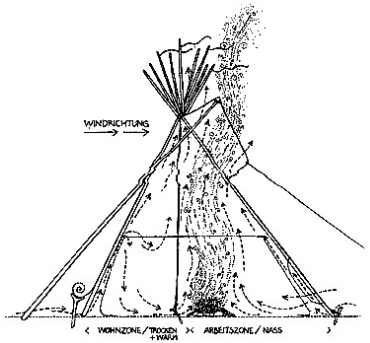
Generally, fire is connected to energy, light, purification, illumination, creation, destruction and metamorphosis. It has the properties of hot and dry, and once people ignited the first fire and gathered around it, it meant overcoming the hostility of the environment and adhering to the natural human needs. ***This has defined the first form of civilization and community.***

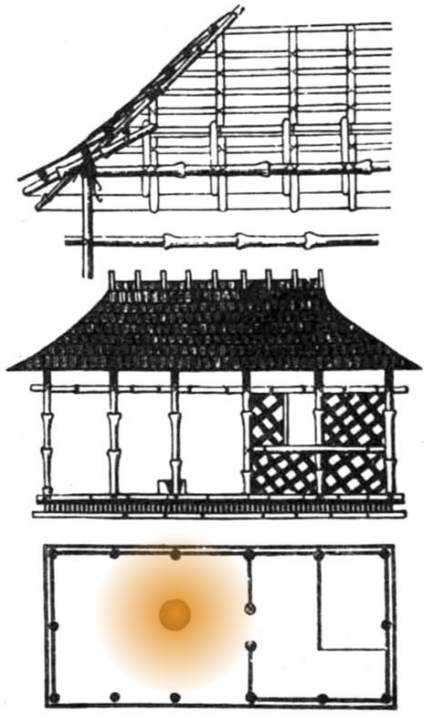


IS FIRE ARCHITECTURAL?

A parable presented by Reyner Banham can be used the illustrate the idea of this. The tale tells about a primitive tribe that has come upon a clearing in the woods where they plan to stay the night. The area is well supplied with fallen timber. Now the tribe faces a dilemma: should they use the wood to build a small shelter or as firewood for a bonfire?

Wood is a material for both construction and combustion. Both methods of use points out two architectural manifestations - one tangible and one intangible. The tribe considers two basic strategies of environmental intervention: regulating natural energy flows through physical structure (hut), or exploiting the energy brought by combustion (fire). ***The thermal space of the bonfire is no less architectural than the physical space of the hut.*** Fire presents a new form of spatial habitation expressed by the radiation of its heat, light, and energy. Moreover, its relations with the physical construction manifestation, the hut, is crucial in how space is oriented around it. What is a house but a hearth?





Primitive Hut, Semper, 1989

Fire + Architecture

“Throughout all phases of society, the hearth formed that sacred focus around which took order and shape. It is the first and most important element of architecture. Around it were grouped the other three elements: the roof, the enclosure, and the mound. The protecting negations or defenders of the hearth’s flame against the hostile elements of nature.”

-Gottfried Semper

Overtime, the idea of the fire and hut has developed into the fundamental elements of Architecture, where the fire is life and the building is the skin which shapes around it. ***The hearth becomes the center of spatial configuration.***

FENG-SHUI AND THE FIRE

Cave-pit-hut: evolution of dwellings, assisted by fireplace and the principles of feng-shui.
(Geomancy and the selection of architecture placement in ancient China,. Ding Yi, Lu Yu, Yong Hong, Hebei: 1996

图 1-5 横穴

horizontal cave

图 1-6 过渡形态穴

cave in transitional period

图 1-9 半穴居前室后寝

half cave housing with a chamber at the front and a bedroom at the back

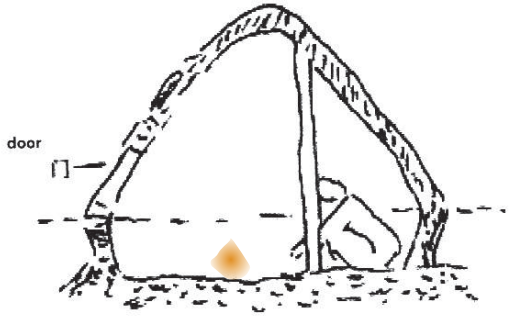


图 1 10 穴壁木骨泥墙，门仍开在屋上

cave wall with wooden frame and mud surfacing, the door is still on top of the house

图 1-7 袋形竖穴（1）

bag-shaped vertical cave

图 1-8 袋形竖穴（2）

bag shaped vertical cave

图 1-11 直壁浅穴的半穴居

half cave housing withvertical walls and shallow digging

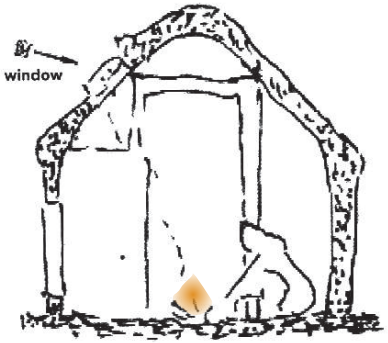
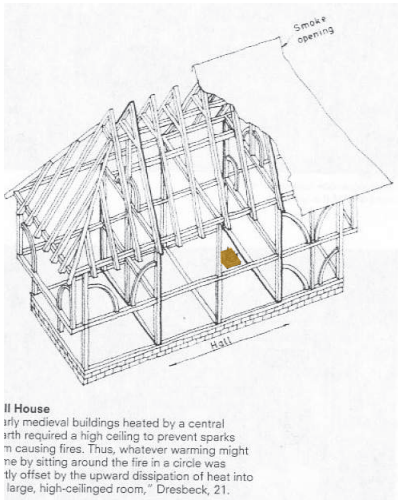
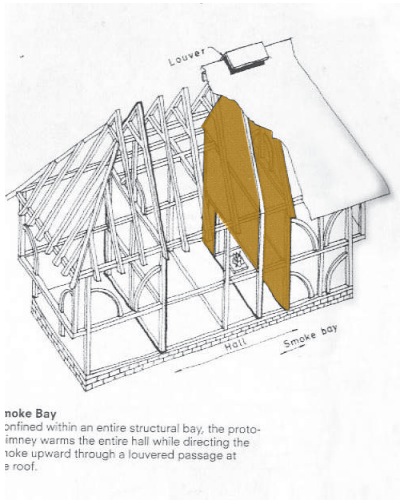


图 1-12 居室的内部结构

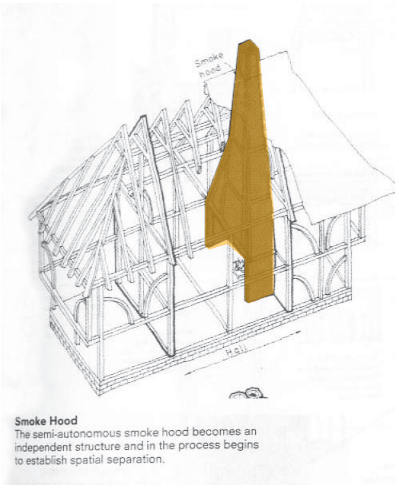
interior structure of housing



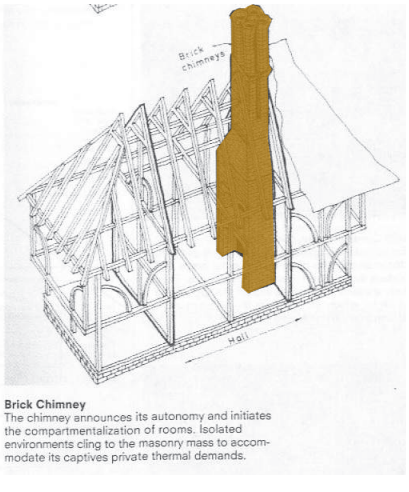
ll House
arly medieval buildings heated by a central
arth required a high ceiling to prevent sparks
m causing fires. Thus, whatever warming might
ne by sitting around the fire in a circle was
tly offset by the upward dissipation of heat into
large, high-ceilinged room," Dresbeck, 21.



noke Bay
onfined within an entire structural bay, the proto-
imney warms the entire hall while directing the
oke upward through a louvered passage at
e roof.



Smoke Hood
The semi-autonomous smoke hood becomes an independent structure and in the process begins to establish spatial separation.

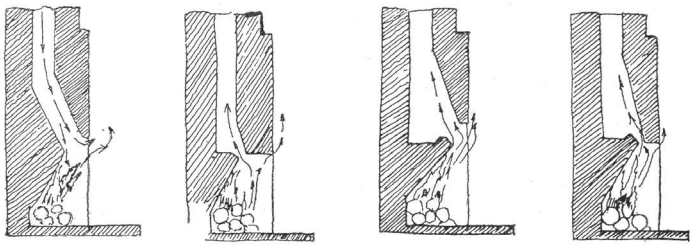


Brick Chimney
The chimney announces its autonomy and initiates the compartmentalization of rooms. Isolated environments cling to the masonry mass to accommodate its captives private thermal demands.

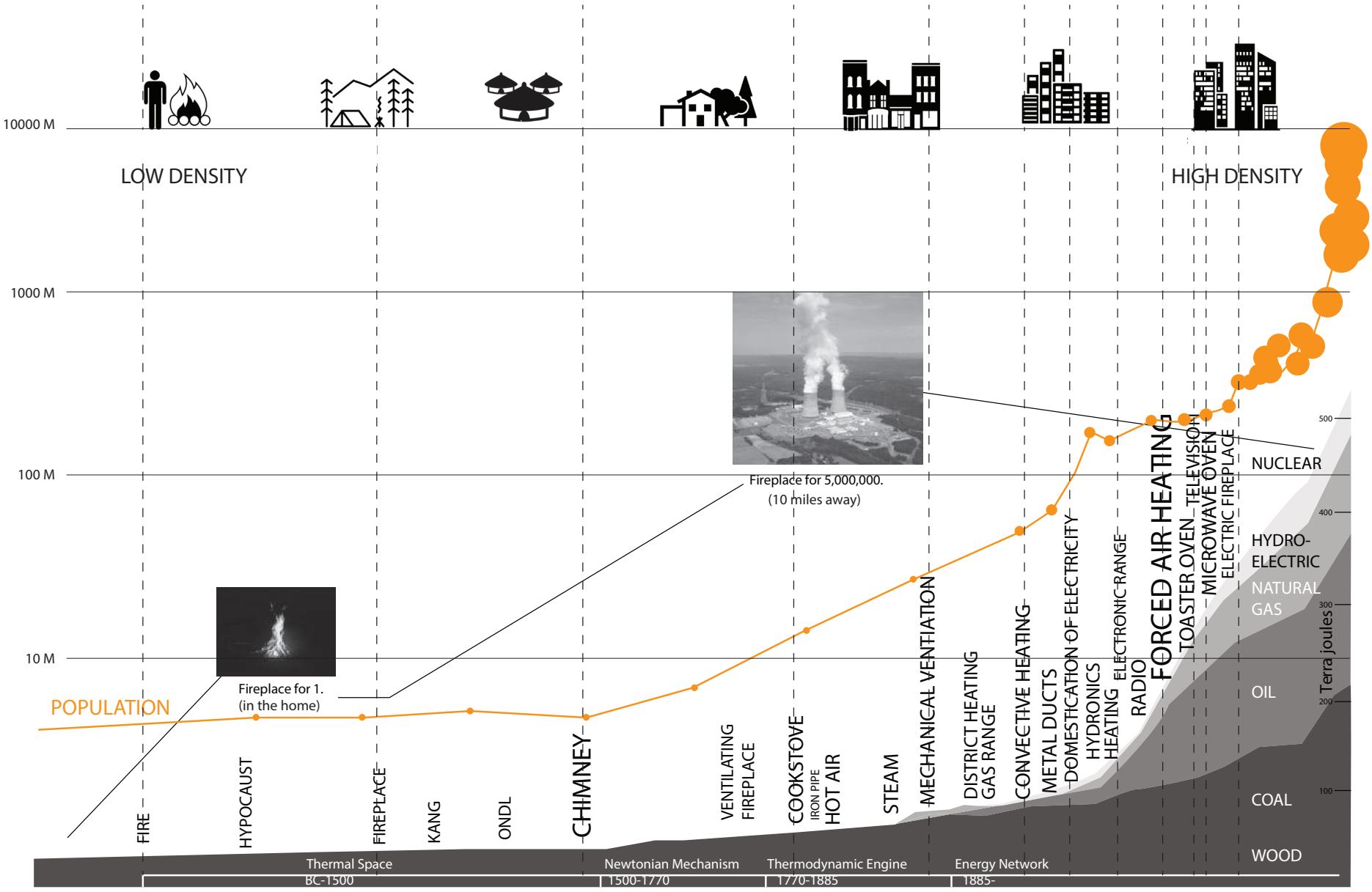
Illustrations from Roxana McDonald, *The Fireplace Book*
(The Architectural Press, London, 1984)

FIRE MIGRATES TO WALL

Throughout the evolution of primitive dwellings, the wall becomes a functional entity, created thick enough to embed a fireplace within it. The wall and the chimney becomes about transporting smoke and controlling convection. No longer is it merely a divider of space, but ***transforms the poche into an active surface of convection, heat, and light.***



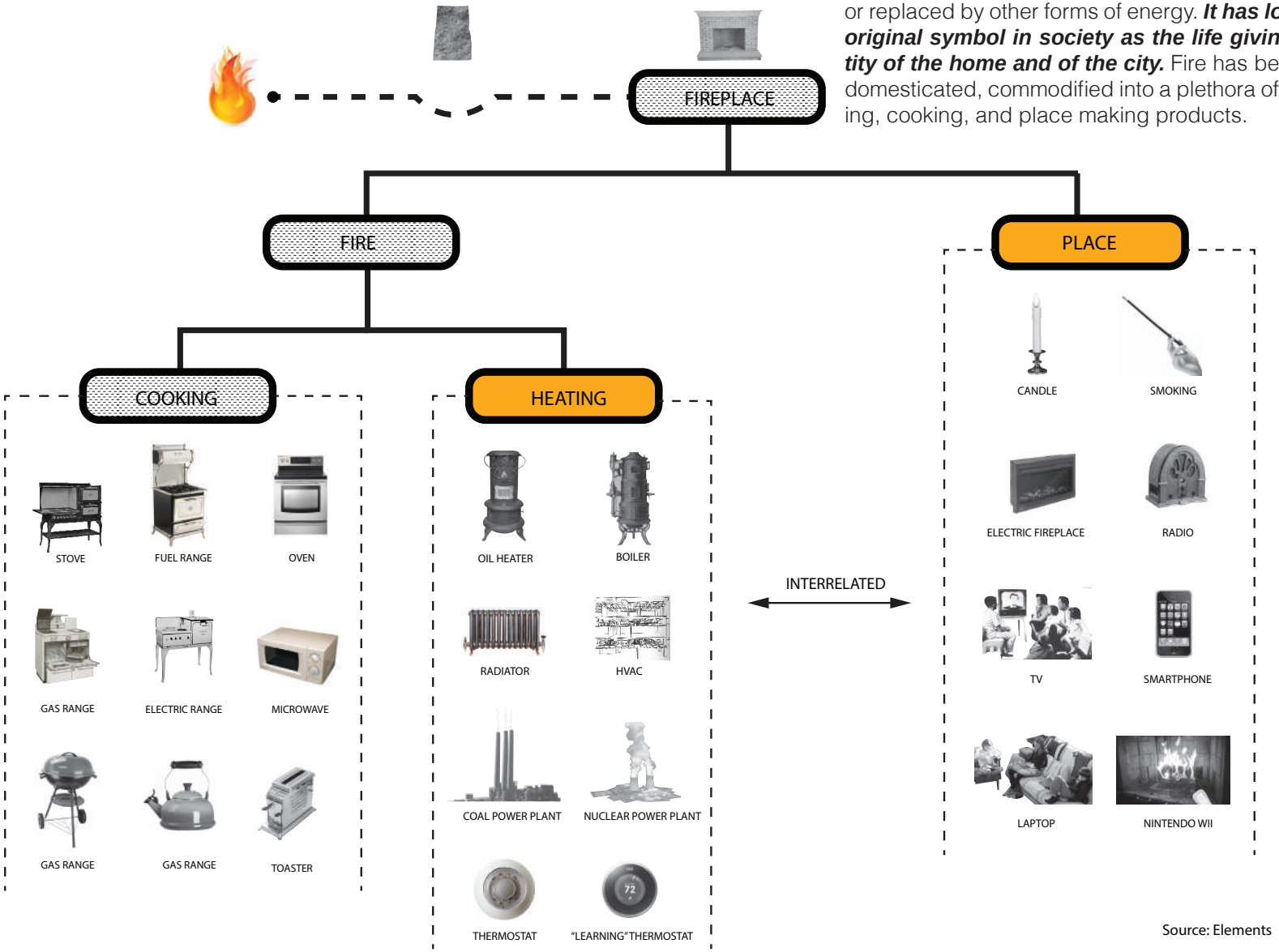
As the population grows and cities densify, the presence of fire continues to diminish, expelled into a distant nuclear plant miles away from the city.



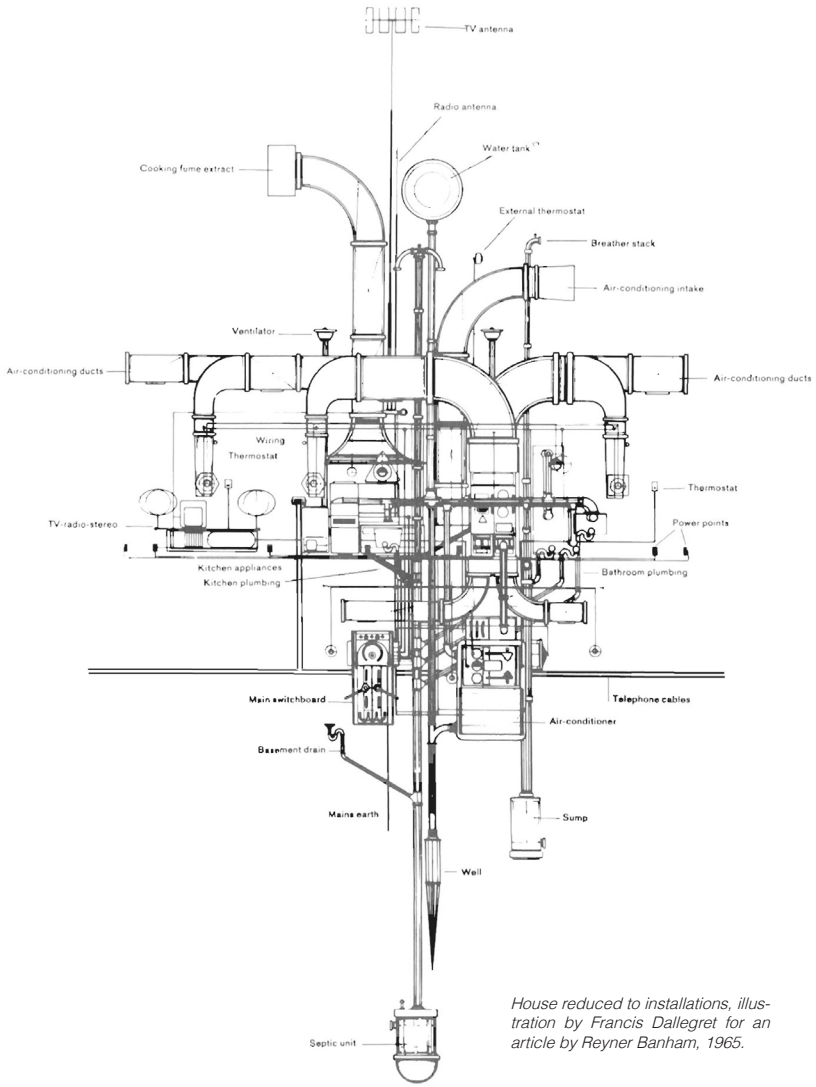
Source: Elements

FIRE IS UNDISCOVERED

As a result, the energy of fire has been transformed into a distant element which is being used discretely in industrial buildings, hidden under basements, or replaced by other forms of energy. ***It has lost its original symbol in society as the life giving entity of the home and of the city.*** Fire has become domesticated, commodified into a plethora of heating, cooking, and place making products.



Source: Elements



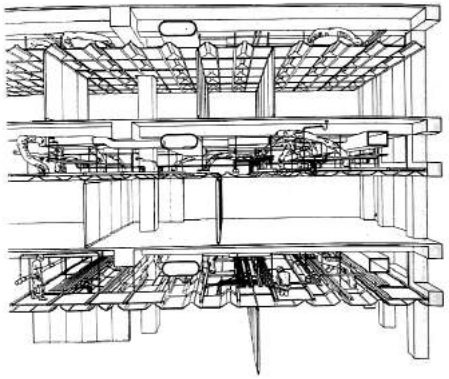
House reduced to installations, illustration by Francis Dallegret for an article by Reyner Banham, 1965.

BUILDING AS A MACHINE: THE LOST OF FIRE

"When your house contains such a complex of piping, flues, ducts, wires, lights, inlets, outlets, ovens, sinks, refuse disposers, hi-fi reverberators, antennae, conduits, freezers, heaters – when it contains so many services that the hardware could stand up by itself without any assistance from the house, why have a house to hold it up?"

-Reyner Banham

The alternative to fire has lead to a plethora of equipment used to support and transfer heat, light, and energy throughout buildings. The function of the hearth, which was once the centralized item, has now become the walls, floors, and ceilings of our buildings.***The wall is no longer recognized as an active surface, but rather, a storage for mechanical equipment concealed under a layer of material finish.***



Academic building of the University of California, 1970.

“THE FIREPLACE MAY BE THE FIRST ARCHITECTURAL ELEMENT TO BECOME EXTINCT”

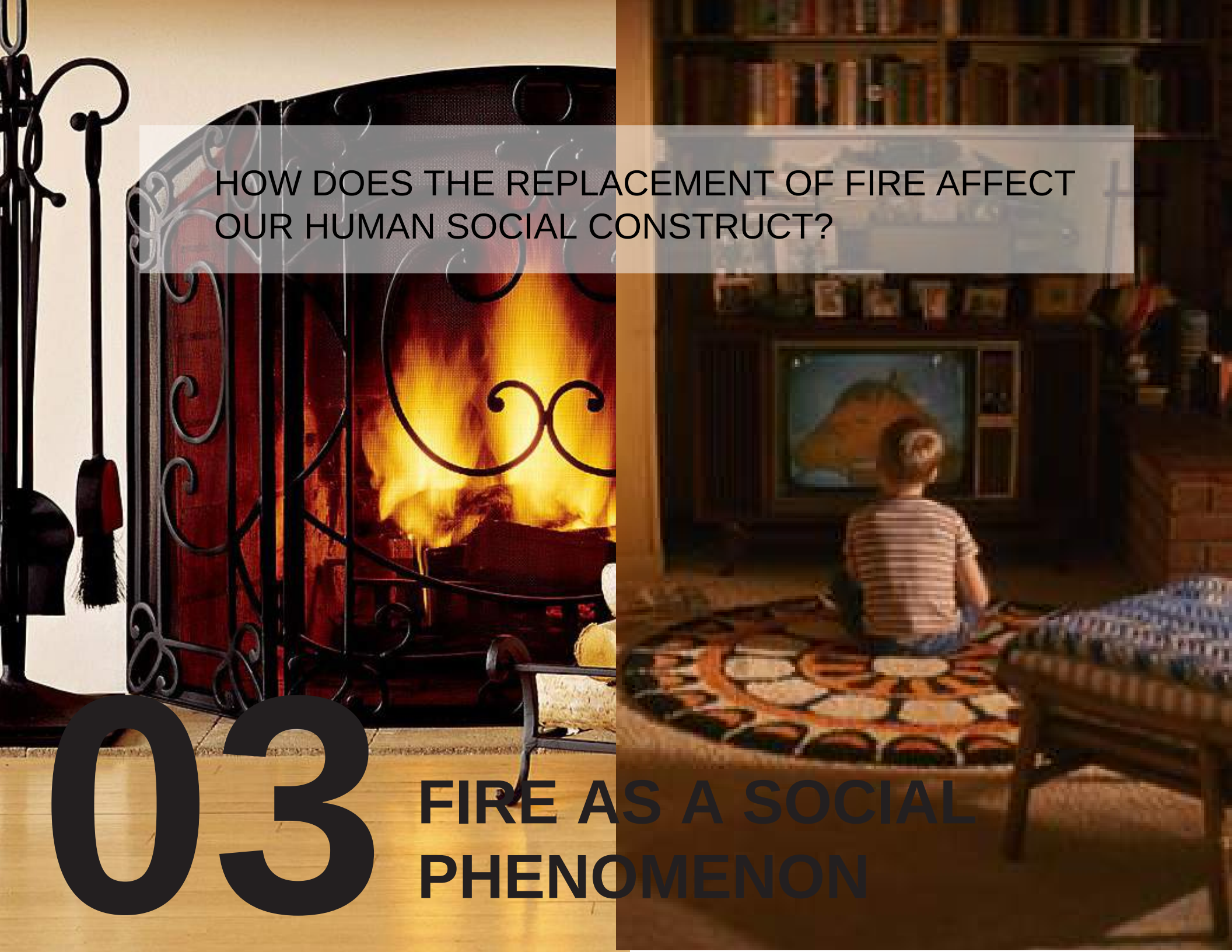
FIREPLACE DEMOLITION PROCESS

Tabletop Firelace
by Gido Wahrmann for Carl Mertens

Planila by Serge Atallah

Designer fires: instead of a piece of architecture, the fireplace becomes an ultraclean, common table-top object.

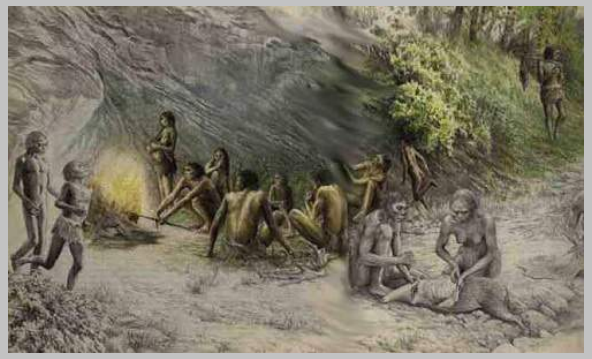
Source: Elements

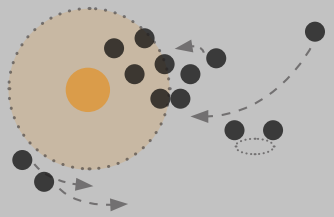


HOW DOES THE REPLACEMENT OF FIRE AFFECT OUR HUMAN SOCIAL CONSTRUCT?

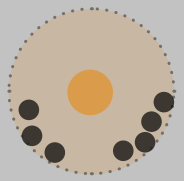
03 FIRE AS A SOCIAL PHENOMENON

FIRE AS SURVIVAL 1000 BC

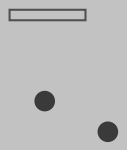




FIRE AS WANT 1920 AD



FIRE AS OBSOLETE 2010 AD



FIRE AND HEARTH AS SOCIAL PHENOMENON

Gather around the fire.

Due to its effect on the progression of human society, fire has played a crucial part in the development of human social structure. It continuously shapes the formation of community activity through it's radiating, multi-functional qualities. As the development of technology relinquishes our dependency on this element, the gathering around fire becomes a strictly social activity, kept around due to it's attractive, mesmerizing nature.

“Now don’t’ start daydreaming!
Soon you’ll have to add more firewood..”

2010 On-screen prompt in the midst of Nintendo Wii game Fire-placing, stoked through an infra-red wand, for homes that have long since exiled the flame from sight, down to a basement boiler, or distant power station

.

Social engagement through fire, in this virtual sense, is limited to a glowing screen, rendering fire as obsolete.

COMMUNITY AND THE CENTRALIZED SOURCE

Our tolerance for social proximity is directly related to our biological need for heat and light. The radiant nature of fire is able to create higher levels of social intimacy through close human proximity. The absence of fire from society has brought upon a new type of culture formed around the notion of individualism. No longer is society bound together by the radial confinement of the heat, but the quest for equal distribution of heat and light has relinquished the need for physical and social attachment.

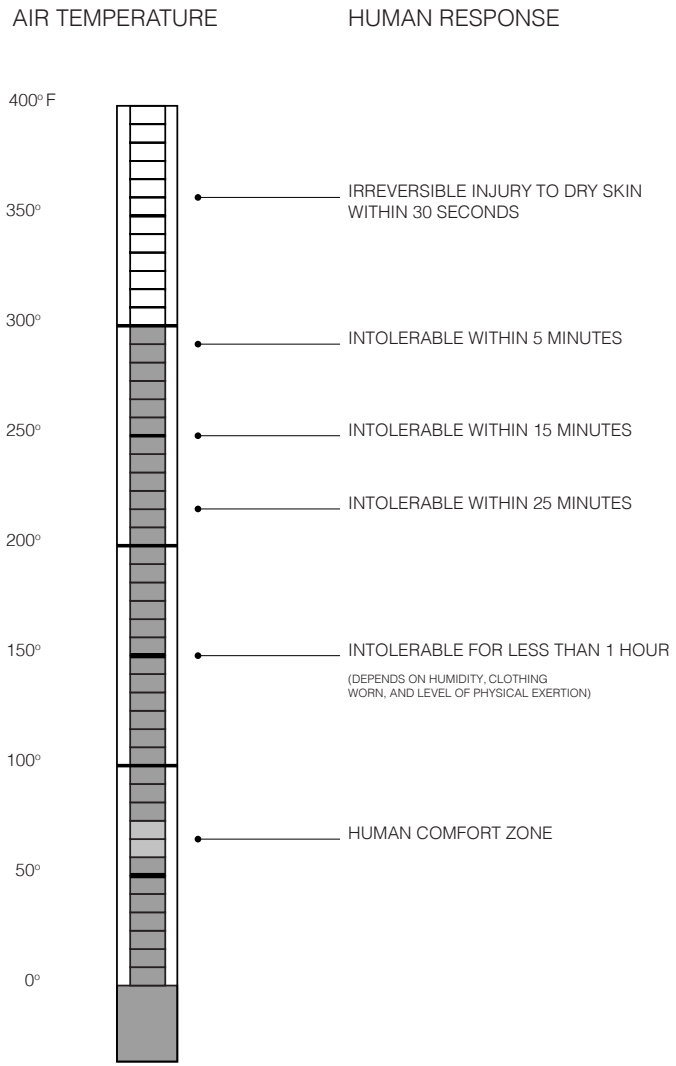
CENTRALIZED SOURCE

DE-CENTRALIZED SOURCE

ATTRACTION

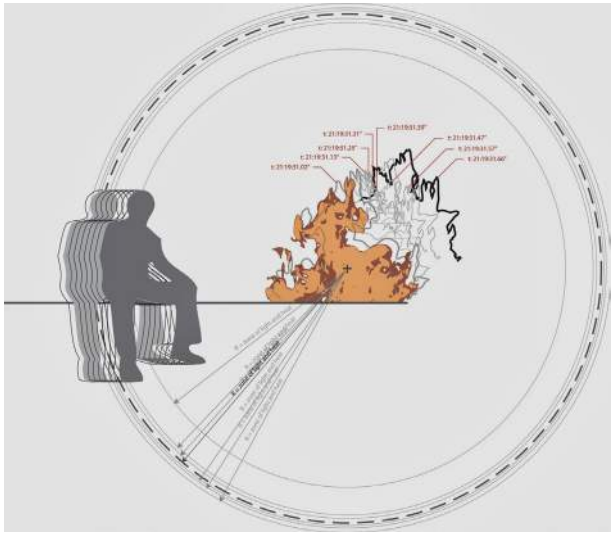
DISPERSION

HEAT FROM FIRE

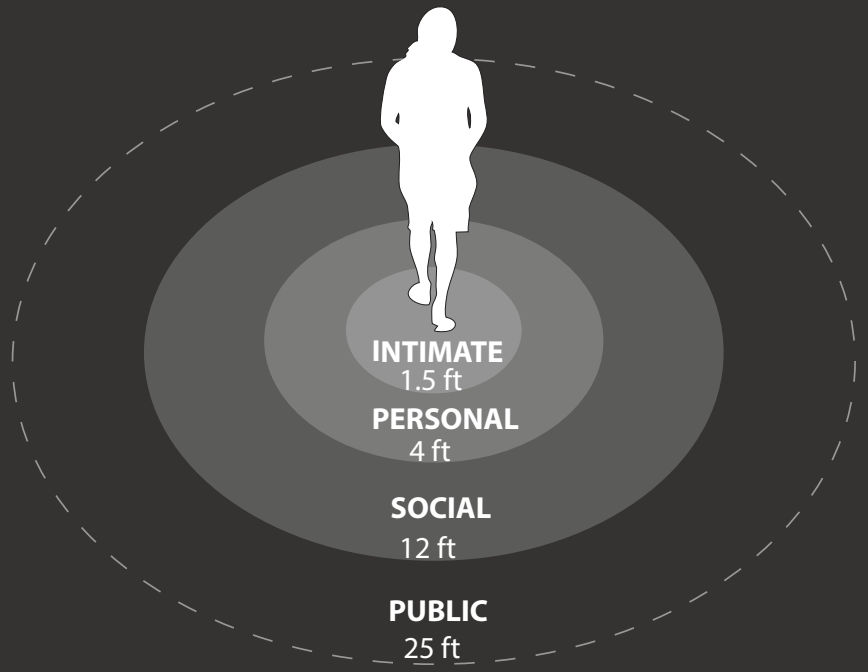


HEAT, LIGHT, AND SPACE

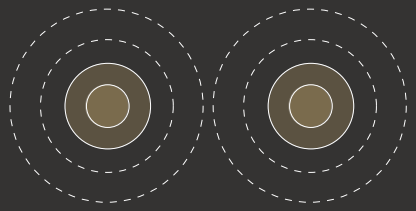
The relation of our interaction with heat and fire is one of attraction and avoidance. Human reactions are the result of our internal temperature measurements in relation to the surrounding environment. When there is fire, our distance to the flames are in relation to the heat that is emitted. When it is cold, we are drawn towards the heat source. When the heat source is too hot, we back away to avoid getting hurt. As a result, heat equals the distance we stand from fire, as well as one another.



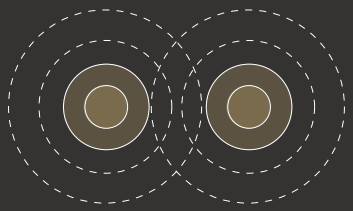
HUMAN PROXEMICS



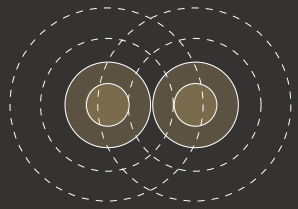
There are four primary levels of human proxemics: intimate, personal, social, and public. The distance between these thresholds pertains to an individualized level of social comfort.



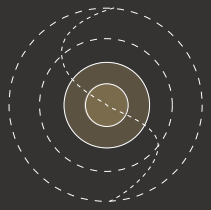
APART SEPARATE



SEPARATE TOGETHER



TOGETHER CONNECTING



CONNECTING INTERSECTING

12-25 ft

4-12 ft

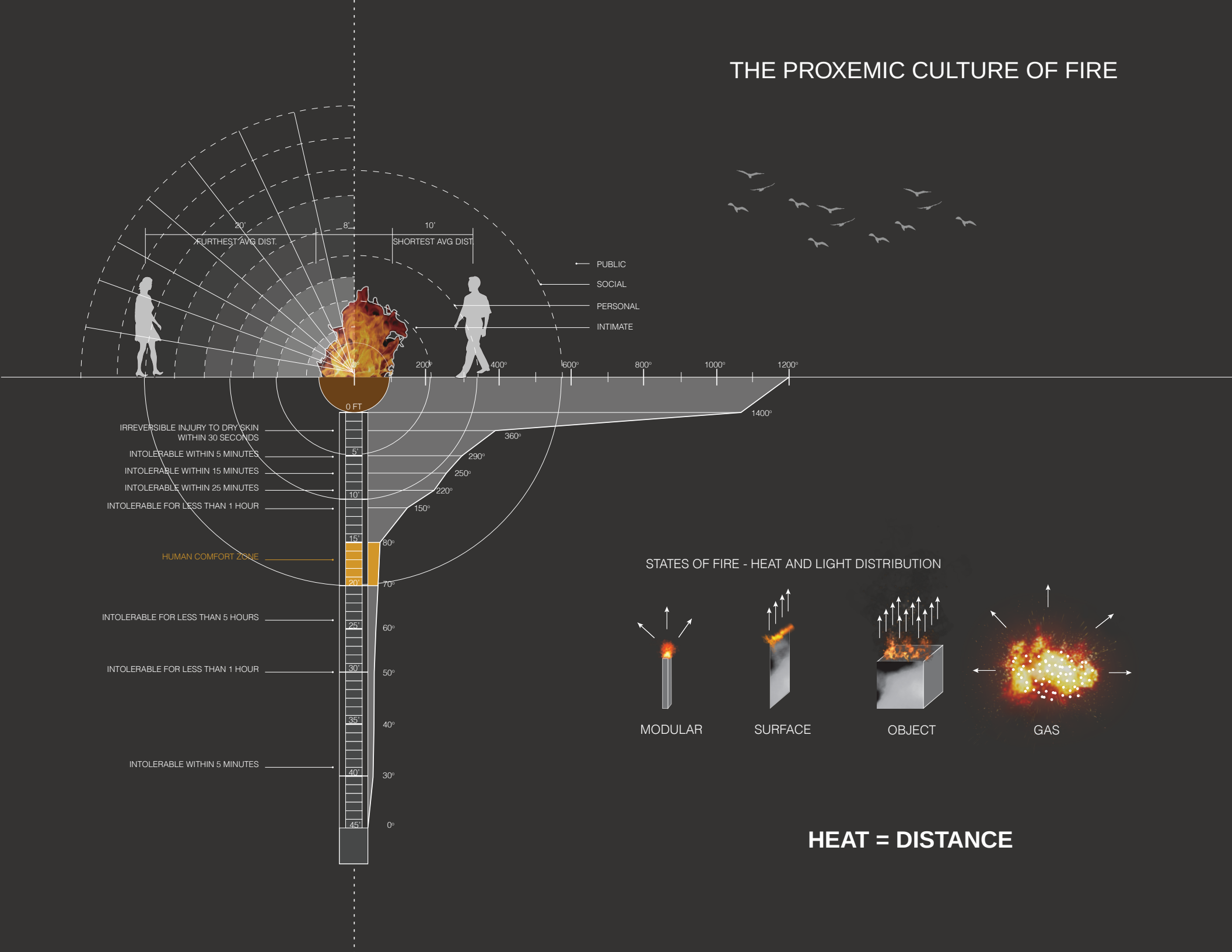
1.5-4 ft

0-1.5 ft

OUR PROXEMITY TOWARDS OTHERS IS DIRECTLY RELATED TO HEAT AND LIGHT DISTRIBUTION

CENTRALIZED - - -

THE PROXEMIC CULTURE OF FIRE



STATES OF FIRE - HEAT AND LIGHT DISTRIBUTION

MODULAR SURFACE OBJECT GAS

HEAT = DISTANCE

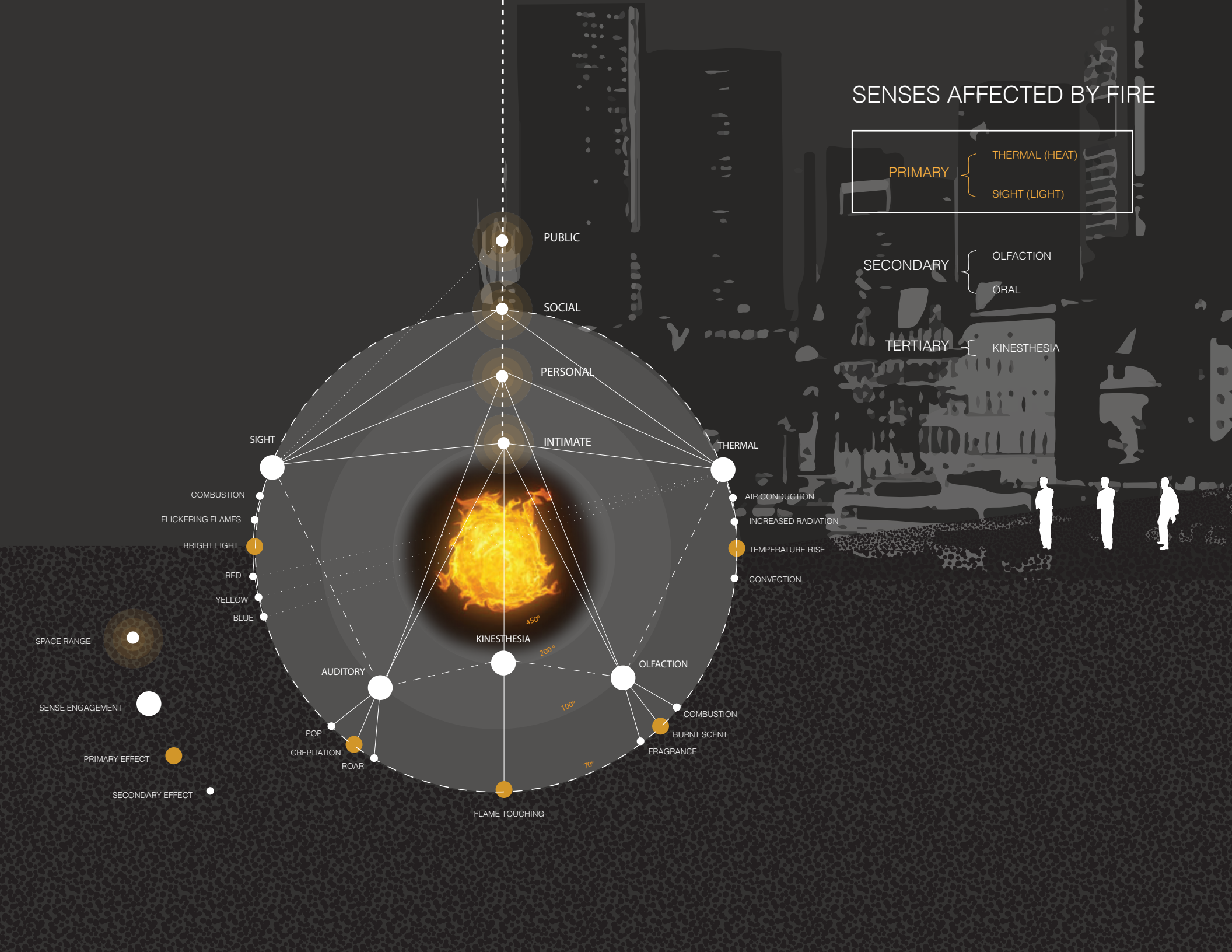
STATES OF FIRE

MODULAR

SURFACE

OBJECT

GAS


SENSES AFFECTED BY FIRE
PRIMARY
THERMAL (HEAT)
SIGHT (LIGHT)
SECONDARY
OLFACTION
ORAL
TERTIARY
KINESTHESIA
PUBLIC
SOCIAL
PERSONAL
INTIMATE
SIGHT
THERMAL
COMBUSTION
FLICKERING FLAMES
BRIGHT LIGHT
RED
YELLOW
BLUE
AIR CONDUCTION
INCREASED RADIATION
TEMPERATURE RISE
CONVECTION
450°
KINESTHESIA
200°
AUDITORY
OLFACTION
100°
POP
CREPITATION
ROAR
COMBUSTION
BURNT SCENT
FRAGRANCE
70°
FLAME TOUCHING
SPACE RANGE
SENSE ENGAGEMENT
PRIMARY EFFECT
SECONDARY EFFECT

04 CASE STUDY: THE BURNING MAN

BLACK ROCK CITY

Population: 67,000

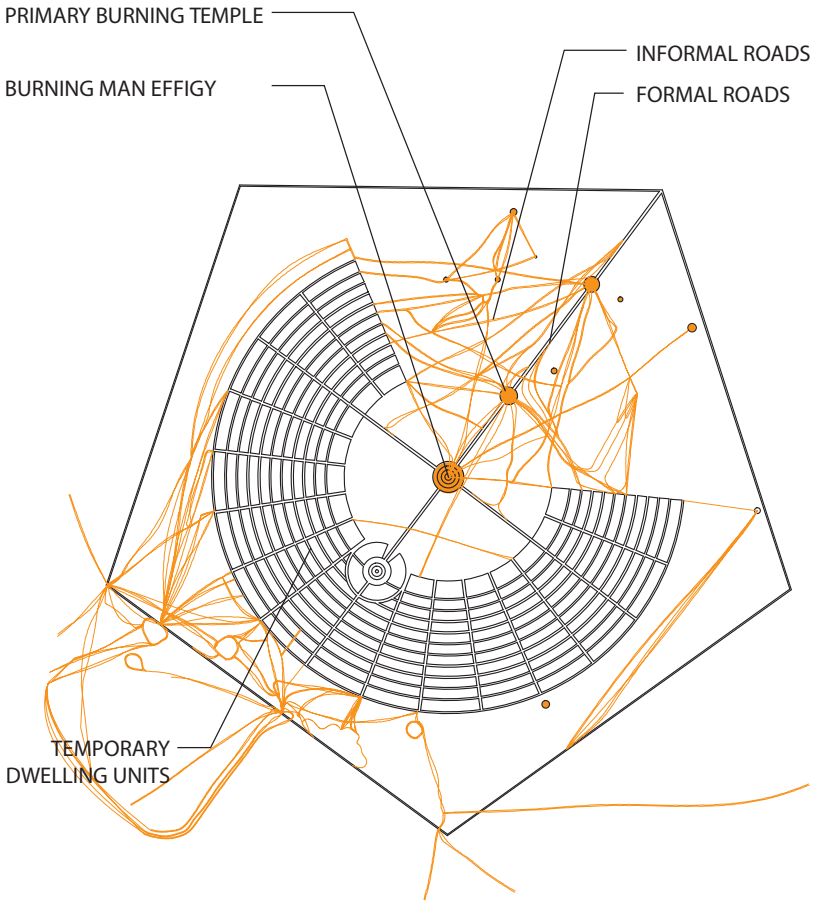
“Once a year, tens of thousands of people gather in Nevada’s Black Rock Desert to create Black Rock City, a temporary metropolis dedicated to community, art, self-expression, and self-reliance. It’s a city wherein almost everything that happens is created entirely by its citizens, who are active participants in the experience.” -Black Rock City

Burning Man Effigy, 2013

Burning Temple of Black Rock City, 2014

CITY OF FIRE

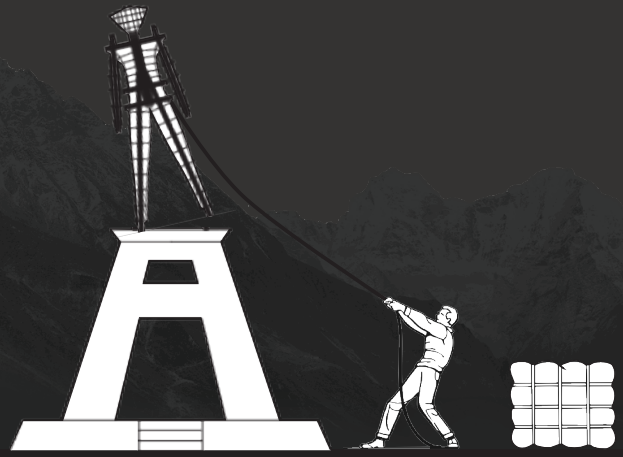
The temporary city is designed around the Burning Man event, where fire is seen as the city's primary organizational structure. Designed artifacts of various scales are implemented throughout the site as its citizens travel to participate in these burnings as a form of community culture.

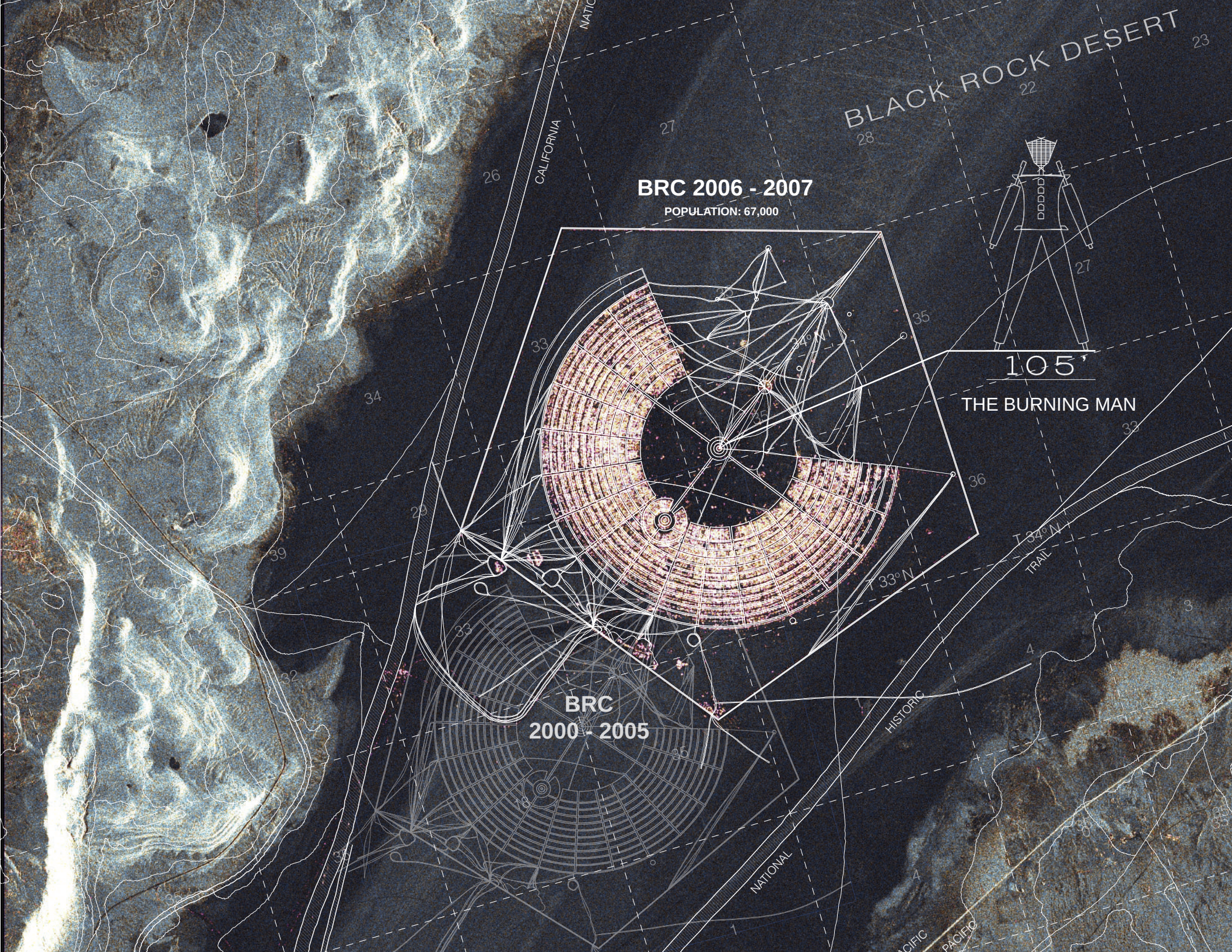


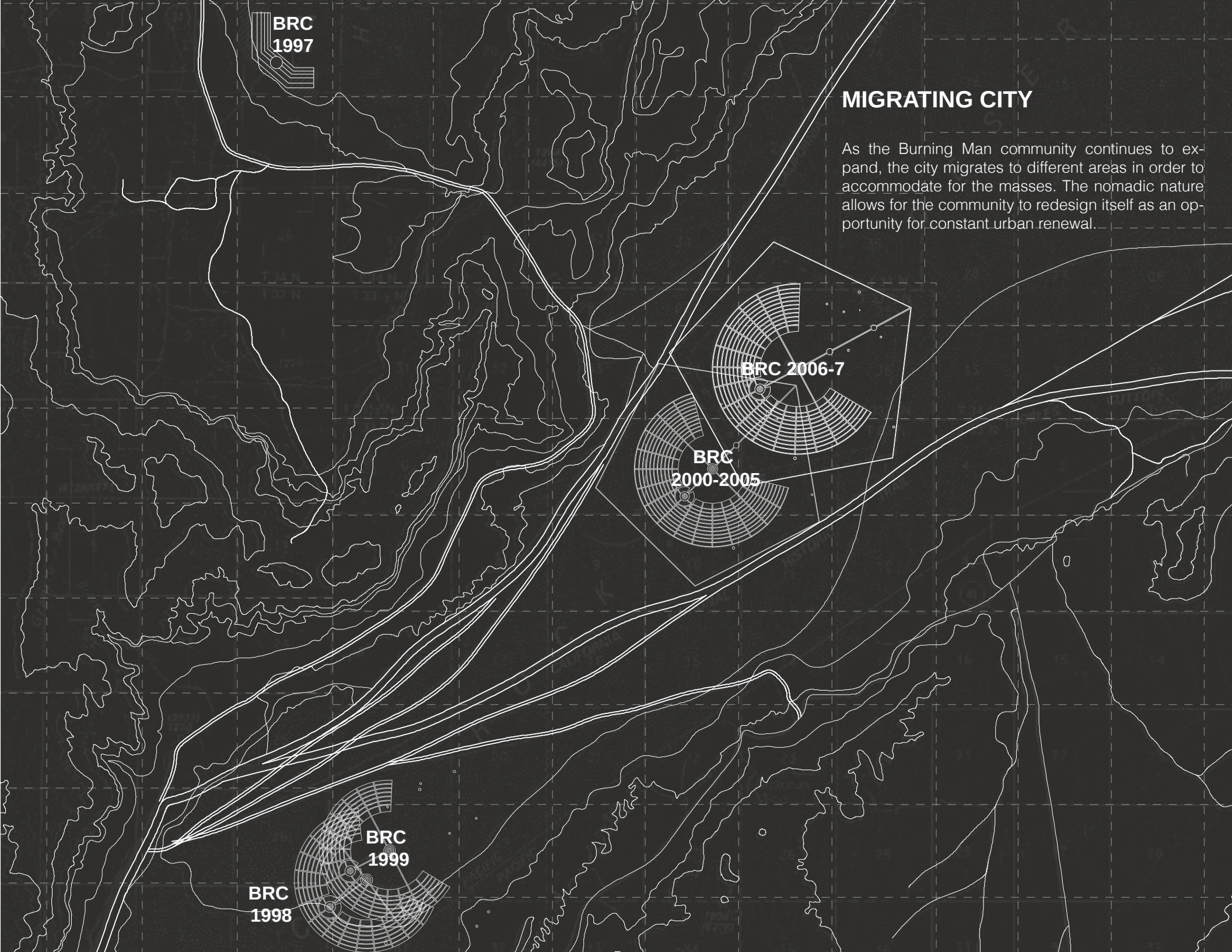
DECOMMODIFICATION

The Burning Man is a city-scaled community designed and built by its inhabitants, known as “Burners.” The process of participation is key in that it is meant to completely release its dwellers from the restrictions of the “default world”, or everyday life. The one week metropolis is meant to replenish a primitive society of authenticity, decommodified and pure. Once over, everything is burned, dismantled, and towed away, leaving the inhabitants renewed through the process of self discovery.

THE BURNING MAN




BLACK ROCK DESERT
CALIFORNIA
NATIONAL
BRC 2006 - 2007
POPULATION: 67,000
105'
THE BURNING MAN
34°N
33°N
TRAIL
HISTORIC
NATIONAL
PACIFIC
BRC
2000 - 2005

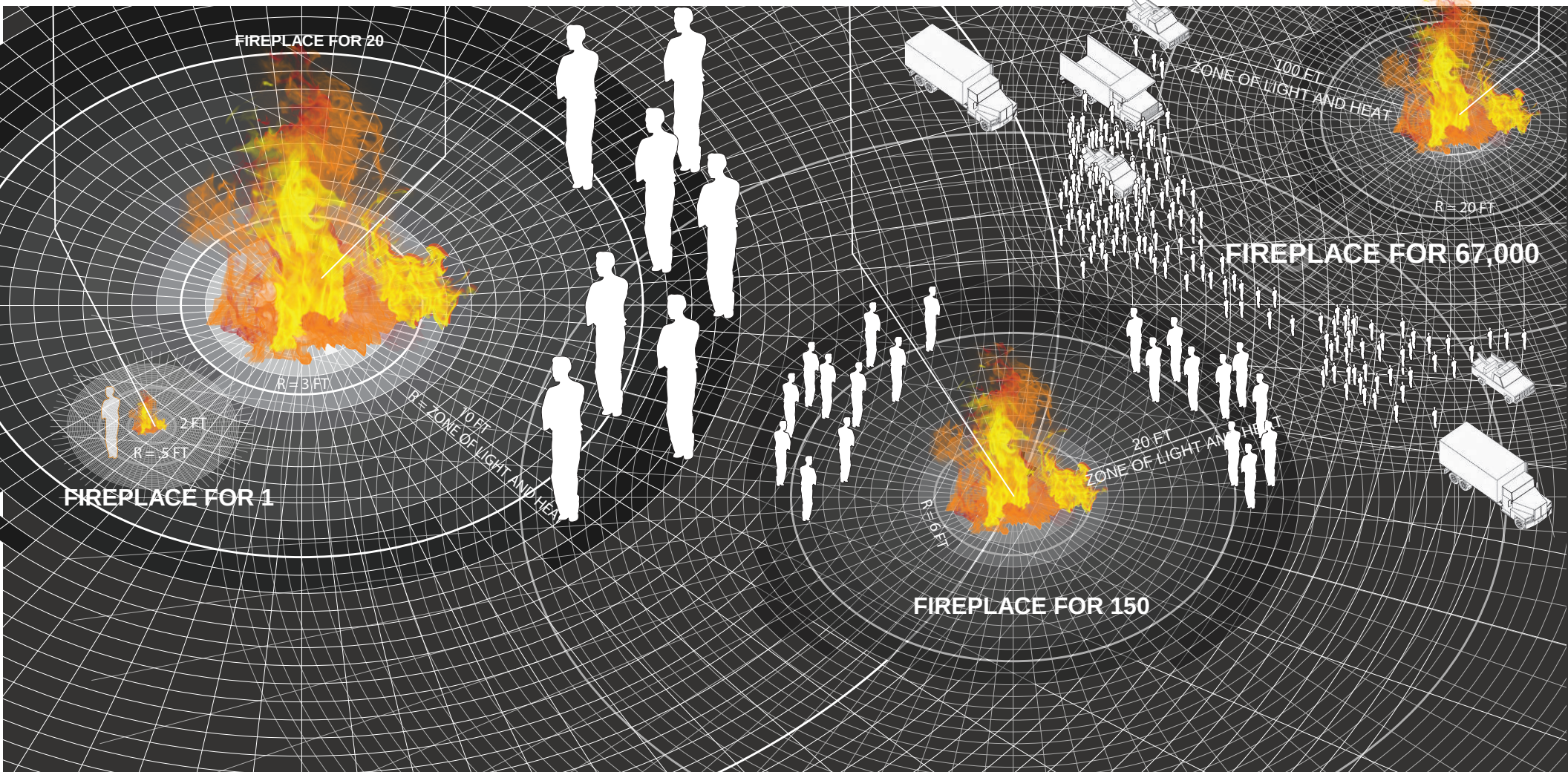


MIGRATING CITY

As the Burning Man community continues to expand, the city migrates to different areas in order to accommodate for the masses. The nomadic nature allows for the community to redesign itself as an opportunity for constant urban renewal.

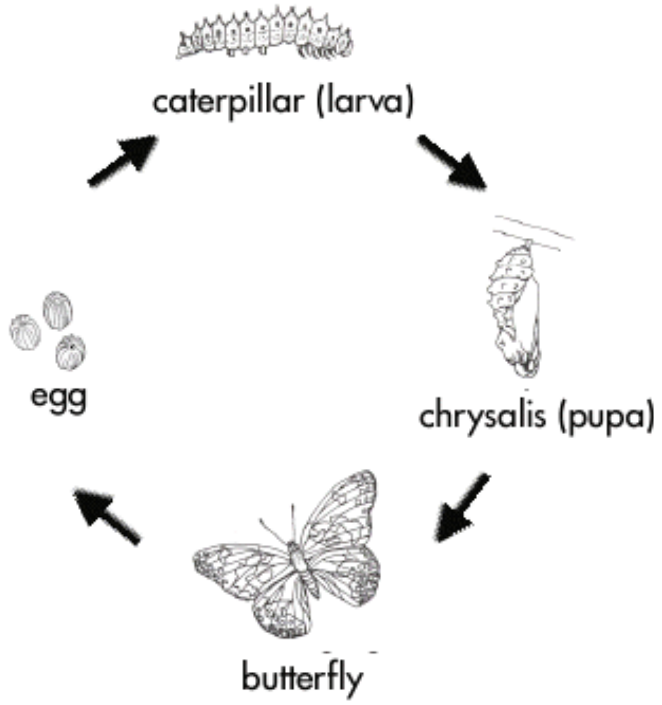
COMMUNITIES OF SCALE

Various scales of human proxemics is achieved through the size of burning artifacts, where the emission of light and heat becomes the defined spatial boundaries. The nature of fire is no longer domesticated or resisted. Rather, it is designed into pieces of art as a form of creative liberation.



05 THE BURNING BUILDING

FIRE AS PLACE



Images reproduced with permission from The Life Cycle of Butterflies.
National Science Resources Center © 1992 The National Academy of Sciences

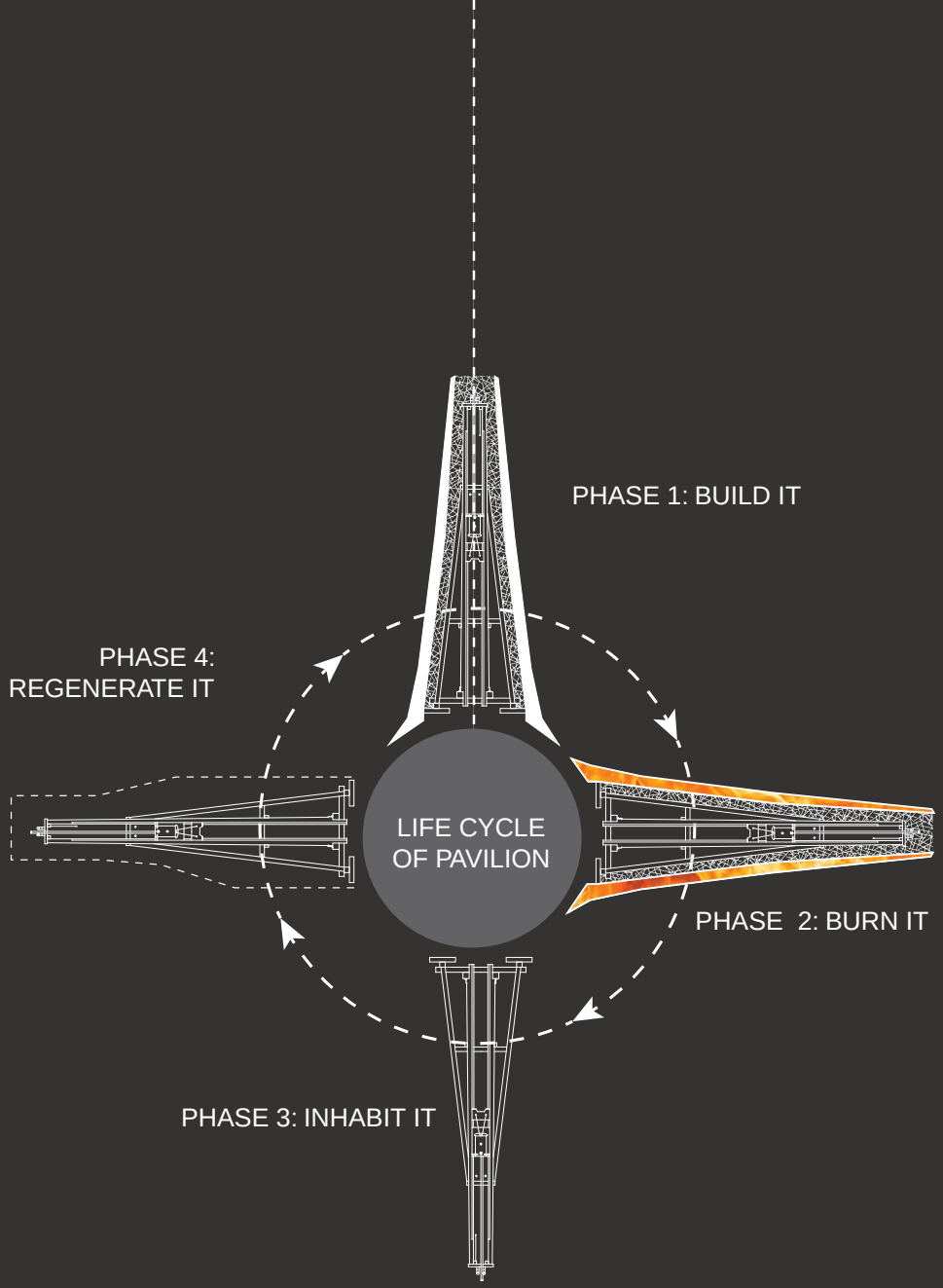
PROXEMIC COMMUNITY

CONTENTION: The near extinction of the fireplace from contemporary society has resulted in a lost of community culture.

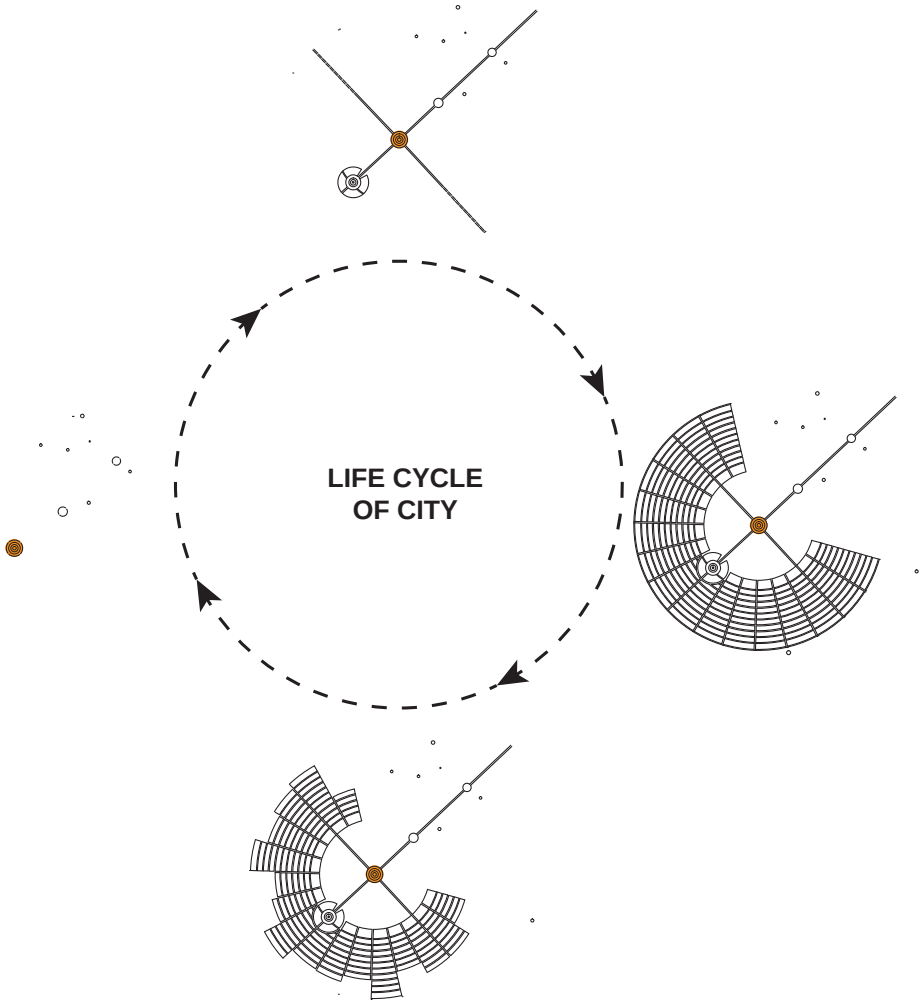
CLAIM: Fire, when controlled, can be used to design social proximity, creating a new form of social phenomenon as a process of reintroducing fire back into contemporary society.

PROJECT: The design of the process of fire takes the form of a burning pavilion that exists in three phases: construction, burning, and exosomatic habitation. The transformative nature of fire brings the burning pavilion into a constant motion of metamorphosis, which in turn creates an instant community culture. The “burning building” becomes an embedded memory of change over time as the community expands and contracts through the process of firemaking. The effect of fire morphs the architectural spatiality and community formation, creating an instant culture and instant city. As the architecture changes, so does the proxemics distance in relation to the scale and emmittance of heat and light through four modes of intimate, personal, social, and public. As a result, the design of the pavilion ultimately serves as a counter culture and criticism against the individualistic commodified culture of contemporary society brought by the extinction of the fireplace. The very essence of a community is once again primal, dictated by the biological need of heat and light.

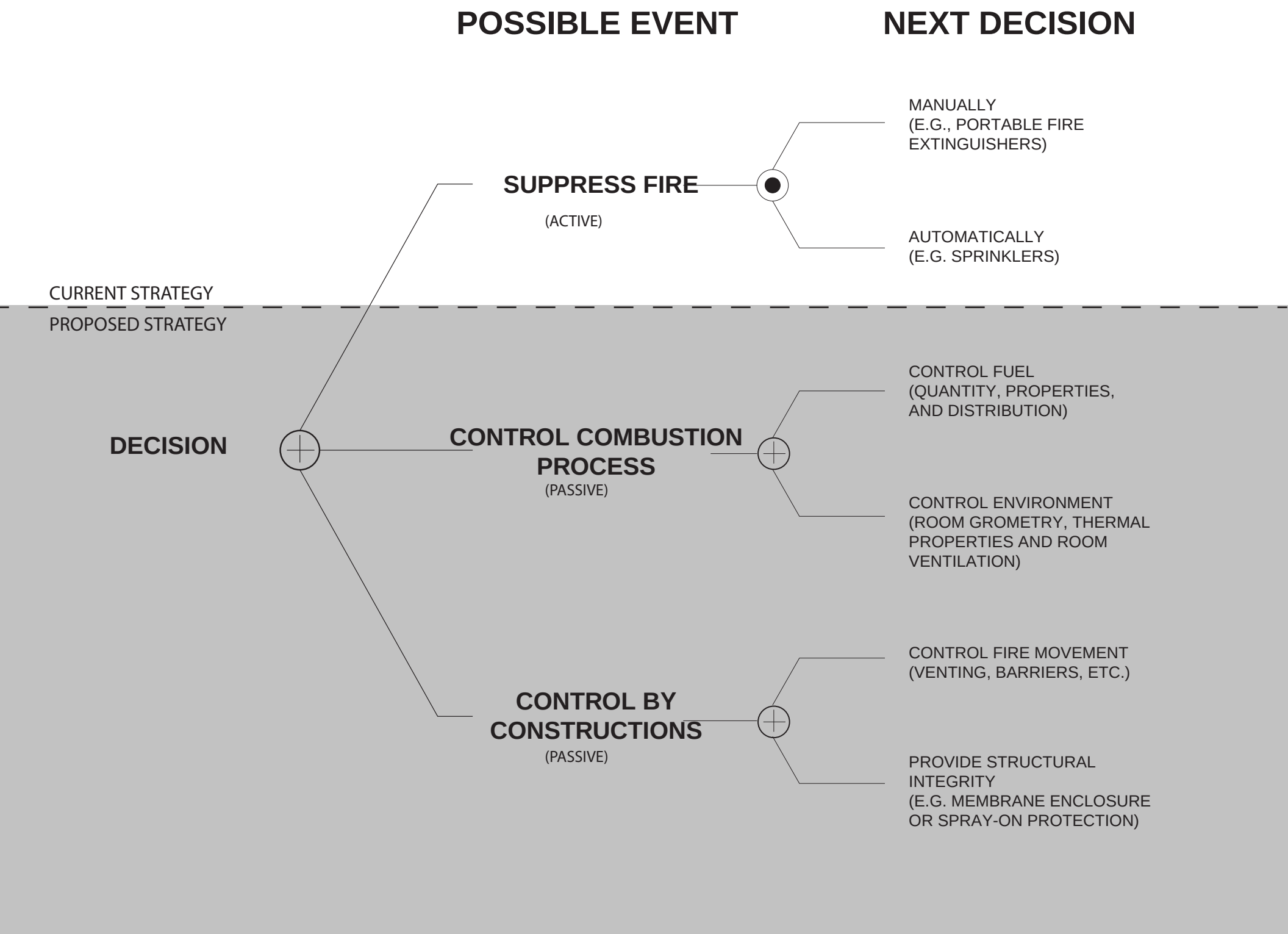
STARTING POINT: Black Rock City



The design of the burning pavilion aims to test methods of how fire can alter and change conditions within architecture. Rather than seeing it as source of destruction, it can activate the artifact into a constant motion that reflects and records the process of change.



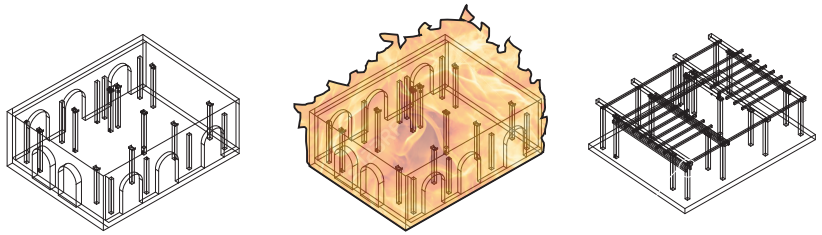
The creation of an proxemic community is achieved through the process of burning. The life cycle of the community structure expands and contracts as it reflects the life cycle of the pavilion.


POSSIBLE EVENT
NEXT DECISION
MANUALLY
(E.G., PORTABLE FIRE
EXTINGUISHERS)
SUPPRESS FIRE
(ACTIVE)
AUTOMATICALLY
(E.G. SPRINKLERS)
CURRENT STRATEGY
PROPOSED STRATEGY
DECISION
CONTROL FUEL
(QUANTITY, PROPERTIES,
AND DISTRIBUTION)
CONTROL COMBUSTION
PROCESS
(PASSIVE)
CONTROL ENVIRONMENT
(ROOM GROMETRY, THERMAL
PROPERTIES AND ROOM
VENTILATION)
CONTROL FIRE MOVEMENT
(VENTING, BARRIERS, ETC.)
CONTROL BY
CONSTRUCTIONS
(PASSIVE)
PROVIDE STRUCTURAL
INTEGRITY
(E.G. MEMBRANE ENCLOSURE
OR SPRAY-ON PROTECTION)

PHASE 1: BUILD IT

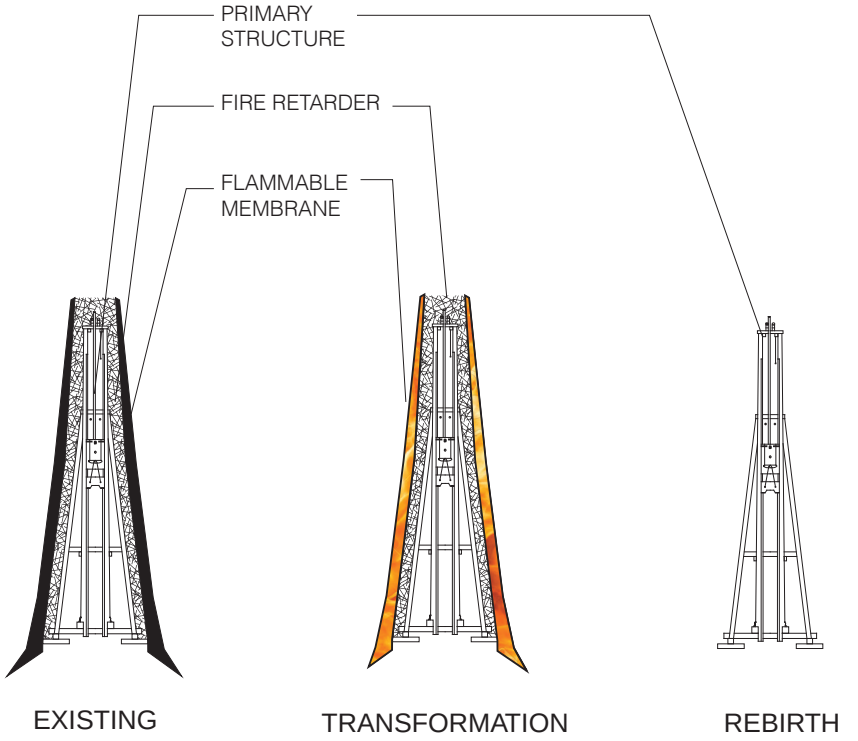
CONTROL COMBUSTION & CONSTRUCTION

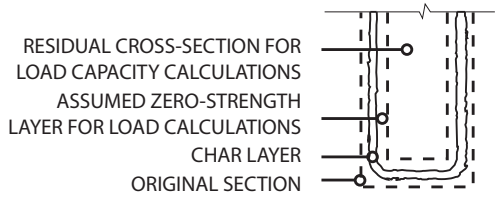
Peer Gastgir Sahib Shrine Fire, *Photo by Jason Pemberton, Photopedia.com*



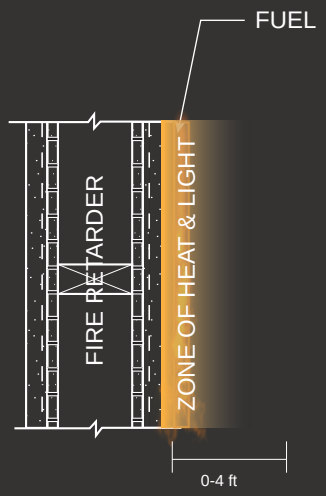
“SLOW BURNING” MULTI-LAYER CONSTRUCTION SYSTEM

The technique of “selective burning” is applied through the process of heavy timber construction, where the process of slow burning is able to control the flammability of each component, allowing the building to burn selectively.

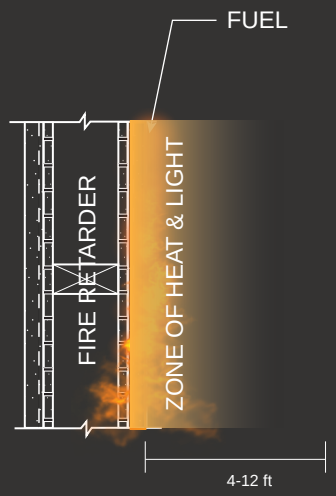




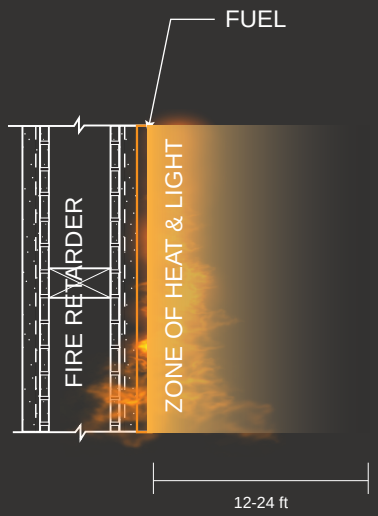
REACTIVATING THE SURFACE
FIRE AS WALL



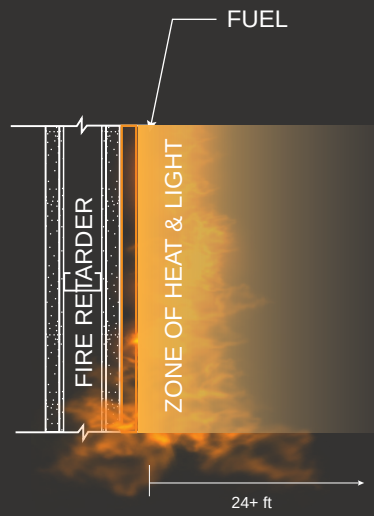
INTIMATE
0-4 ft



PERSONAL
4-12 ft



SOCIAL
12-24

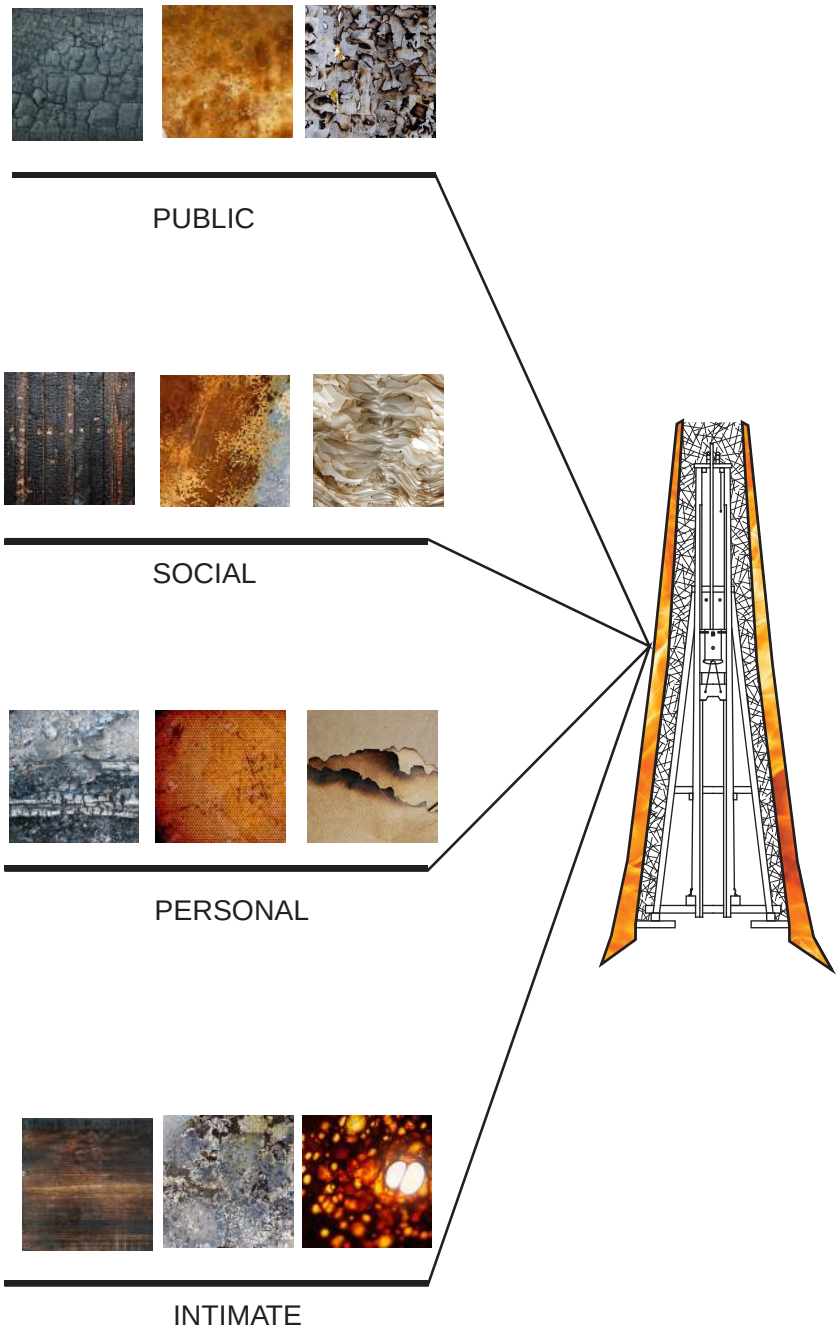


PUBLIC
24+ ft

PHASE 2: BURN IT

CONTROL OF FIRE PROXEMICS

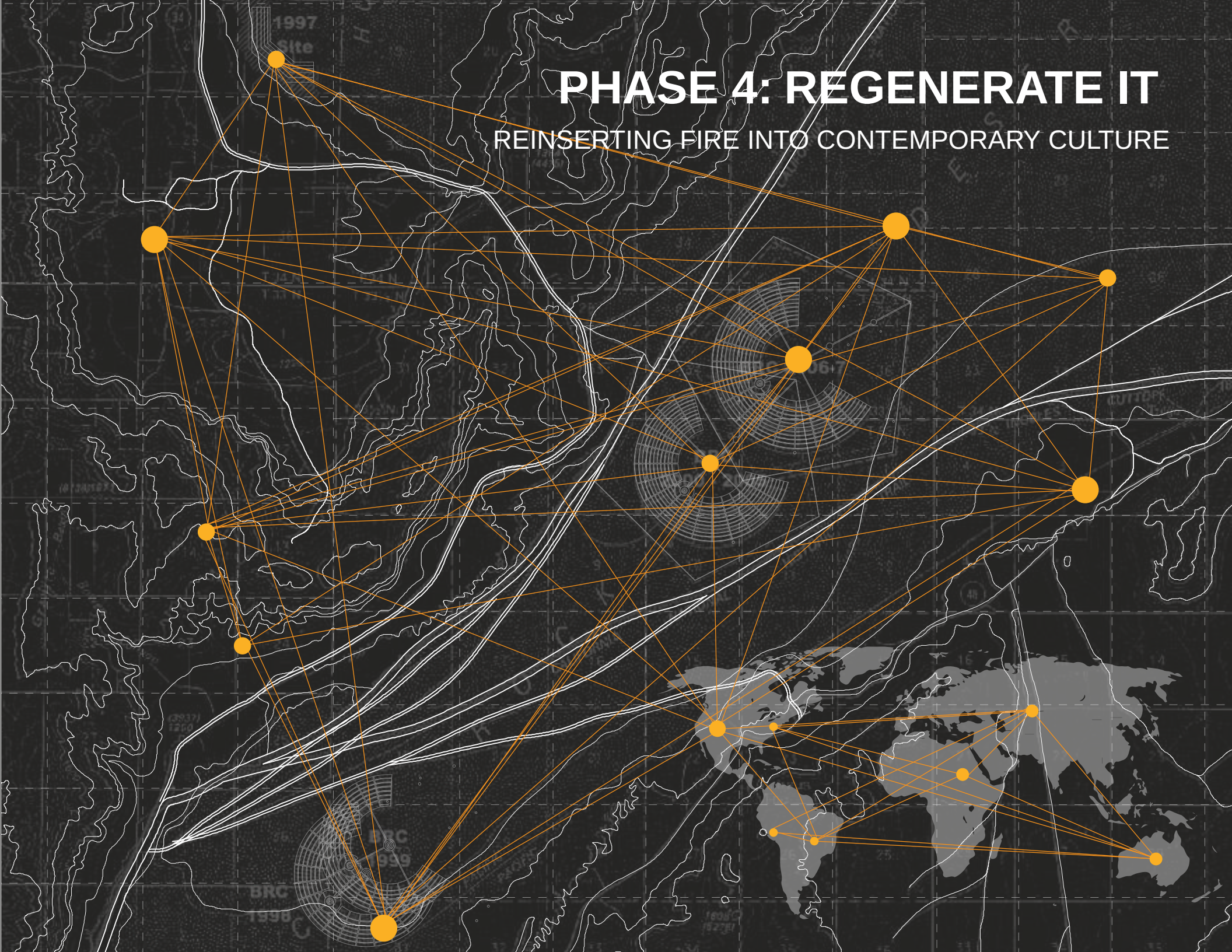
The formal strategy of the pavilion manipulates the heat and light dissipated from fire through a layering process of fire resistive construction and flammable material. The distance of heat and light emitted formulates, respectively, different social nodes of intimate, personal, social, and public spaces contingent upon the length of the radiated surface.



PHASE 3: INHABIT IT

CONTROL EXOSOMATIC RESULT

Because the pavilion is burning at different rates of fire intensity, the effect it has on the burnt material will reflect the social space that was intended through the control of fire. The temperature indicates where the maximum intensity is. If a flame hot, it can ionize the atoms around it, leaving a trace of oxidized deformation. The burnt surface then becomes an object of memory as effects of fire is embedded within it.



PHASE 4: REGENERATE IT

REINSERTING FIRE INTO CONTEMPORARY CULTURE

BIBLIOGRAPHY

BOOKS

Banham, Reyner. The Architecture of the Well-tempered Environment. Chicago: University of Chicago, 1969.

Debaigts, Jacques. The Modern Fireplace. New York: Van Nostrand Reinhold, 1975.

Egan, M. David. Concepts in Building Firesafety. New York: Wiley, 1978.

Galiano, Luis. Fire and Memory on Architecture and Energy. Cambridge, Mass.: MIT Press, 2000.

Hall, Edward T. The Hidden Dimension. Garden City, N.Y.: Doubleday, 1966.

Hall, Edward T. Handbook for Proxemic Research. Washington, D.C.: Society for the Anthropology of Visual Communication, 1974.

Heschong, Lisa. Thermal Delight in Architecture. Cambridge, Mass.: MIT Press, 1979.

Kelly, Alison. The Book of English Fireplaces. Feltham: Country Life Books, 1968.

Koolhaas, Rem, and Mass Cambridge. Elements of Architecture. Venice: Marsilio, 2014.

Mateo, Jose. Earth, Water, Air, Fire: The Four Elements and Architecture.

Moe, Kiel. Thermally Active Surfaces in Architecture. New York: Princeton Architectural Press, 2010.

Przetak, Louis. Standard Details for Fire-resistive Building Construction. New York: McGraw-Hill, 1977.

Sommer, Robert. Social Design: Creating Buildings with People in Mind. Englewood Cliffs, N.J.: Prentice-Hall, 1983.

WEBSITES

“1986.” Burning Man. Accessed December 15, 2015. http://burningman.org/timeline/.

“Ch 07 Heavy Timber and Mill Construction.” Ch 07 Heavy Timber and Mill Construction. Accessed December 15, 2015. http://www.slideshare.net/sno-shoesam/ch-07-heavy-timber-and-mill-construction.

“The Culture | Burning Man.” Burning Man. Accessed December 15, 2015. http://burningman.org/culture/.

“Engineering and Construction.” FIRE-RESISTIVE HEAVY TIMBER CONSTRUCTION. Accessed December 15, 2015. http://www.thecivilbuilders.com/2013/09/fire-resistive-heavy-timber-construction.html.

“FIRE - FLAMES Modeling & Simulation Software by Ternion.” FLAMES Modeling & Simulation Software by Ternion. Accessed December 15, 2015. http://www.ternion.com/fire/.

“Fundamentals of Building Construction, Materials & Methods, 5 Th Edition Copyright © 2009 J. Iano. All Rights Reserved. History Simple Timber-Framed.” Presentation “ Structures.” Accessed December 15, 2015. http://slideplayer.com/slide/1421795/.

Wolchover, By. “Why We Are Drawn to Fire.” LiveScience. April 23, 2012. Accessed December 15, 2015. http://www.livescience.com/19853-fire-fascination.html.

JOURNALS

Fessler, Daniel M. T. A Burning Desire: Steps toward an Evolutionary Psychology of Fire Learning. Emmitsburg, MD: [National Emergency Training Center], 2006.

Langenbach, R. “Better than Steel? (Part 2).” Structures and Architecture New Concepts, Applications and Challenges, 2013, 122-39.